The Effect of an Exercise Intervention on Mood is Mediated by Eating Attitude Change

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I declare that this report is my own original work and that contributions of others have been duly acknowledged.

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Abstract

Physical exercise is associated with improved mood and psychological wellbeing, but the underlying mechanisms remain unclear. We assessed the relative importance of change in exercise, weight-loss and psychological variables (social support, self-esteem, self-efficacy, disordered eating attitudes and body image) in predicting changes in mood following an exercise intervention; and tested the mediating role of disordered eating attitudes in the relationship between exercise intervention and mood improvement. Adult women enrolled in a 12 week exercise intervention (GFC group) (N=17) or a control group (N=40) were assessed for key exercise, weight, mood and psychological wellbeing variables at four time points across a 16 week period. Significant positive mood and psychological wellbeing changes were observed in the GFC group but not the control group following the 12 week exercise intervention. Regression analysis revealed decrease in disordered eating attitudes to be the most consistent and significant predictor of positive mood change associated with exercise intervention. Mediation analysis revealed that disordered eating attitude change was a significant mediator of mood improvements observed following the exercise intervention. This study provides preliminary evidence to suggest an important role of disordered eating attitudes in understanding exercise-related mood improvements and supports models that highlight the importance of psychological aspects to exercise interventions.

Obesity is increasingly prevalent in adults and children, and is associated with a wide range of physical and psychological consequences, including increased morbidity and mortality, as well as alterations in depression, anxiety, attitudes about oneself, and disordered eating attitudes (Dixon, Dixon, & O'Brien, 2003; Osei-Assebey, Kyrou, Kumar, Saravanan, & Matyka, 2010). An increase in body mass index (BMI) has been consistently related to an increase in affective disorders, with obese women particularly prone to anxiety and depression (Wright et al., 2012; Simon et al., 2006). A recent systematic review (Atlantis & Baker, 2008) and meta-analysis (de Wit, Luppino, van Straten, Pennix, Zitman, & Cuijpers, 2010) confirmed associations between depression and obesity. Whilst the link between obesity and affective disorders is widely established it remains poorly understood (Luppino et al., 2010; Vogelzangs et al., 2010). It has been proposed that both the depressed and anxious person, through dysregulated stress systems (Bornstein, Schuppenies, Wong, & Licinio, 2006), and/or unhealthy lifestyle results in an increase in obesity over time (Luppino et al., 2010), and alternatively that obesity, and the associated negative sequelae including physical and psychosocial consequences results in the development of depression and anxiety with time (Vogelzangs et al., 2010). A meta-analysis examining longitudinally whether obesity increased the risk of depression and whether depression increased the risk of developing obesity revealed significant bidirectional associations between depression and obesity (Luppino et al., 2010). Such findings provide clear evidence that obesity and depression and anxiety interact reciprocally resulting in considerable implications for clinical practise (Luppino et al., 2010).

Exercise is a strong predictor of weight loss and is the strongest predictor of weight-loss maintenance (Annesi & Whitaker, 2010; Fogelholm & Kukkomen-

Harjula, 2000; Miller, Koceja, & Hamilton, 1997; Pronk, & Wing, 1994; Wadden, Vogt, Foster, & Anderson, 1998). However, the role of exercise in weight loss remains unclear. Recently, it has been proposed that the effects of exercise are associated with improvement in psychological factors which occur during engagement in exercise interventions (Annesi & Unruh, 2008; Donnelly et al., 2009). Whilst the efficacy of exercise interventions on weight loss is well established (Curioni & Lourenco, 2005; Wadden, Butryn, & Byrne, 2004), recent research suggests exercise interventions improve a number of psychological variables including mood, body image, self-efficacy, self-esteem, disordered eating attitudes and social support (Annesi & Whitaker, 2008; Critchley, Hardie, & Moore, 2012; Dixon et al., 2003; Palmeira et al., 2010; Wadden et al., 1997). Whilst the positive effect of exercise on mood appears robust, to date relatively few studies have examined the mechanisms underlying the impact of exercise on mood (Teixeira, Going, Sardinha, & Lohman, 2005). Specifically, is the impact of exercise on mood mediated by changes in self-esteem, self-efficacy, social support, body image or disordered eating attitudinal change? The current study aims to examine this question following an exercise intervention in women.

Effect of Exercise on Mood

Within the exercise literature, meta-analyses and systematic reviews reveal robust positive effects of exercise on mood and psychological wellbeing (Craft & Perna, 2004; Lawlor & Hoper, 2001; Long & van Stavel, 1995; Peluso & de Andrade, 2005; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991; Salmon, 2001; Scully, Kreer, Meade, Graham, & Dudgeon, 1998; Smith et al., 2007; Stathopoulou, Powers, Berry, Smits, & Otto, 2006; Wipfli, Rethorst, & Landers, 2008; Zschucke, Gauditz, & Strohle, 2013). Benefits such as reduced anxiety and

depression have been reported both acutely after exercise (Martinsen, 2008) and following involvement in exercise interventions (Annesi, Unhruh, & Whitaker, 2007). Within the depression literature, meta-analyses have revealed that exercise is effective in reducing symptoms of depression in both men and women, across all ages and severities of depressive symptoms (Lawlor & Hopkor, 2001; Zschucke et al., 2013). Recent meta-analyses, which have investigated effects of exercise interventions on anxiety outcomes, have reported exercise to reduce anxiety in healthy adults (Conn, 2010; Zschucke et al., 2013); and in adults with clinical anxiety (Long & van Stavel, 1995; Wipfli et al., 2008; Zschucke et al., 2013). Furthermore, engagement in an exercise intervention has been consistently reported to result in reduced levels of both trait and state anxiety (Herring, O'Conner, & Dishman, 2010; Petruzzello et al., 1991; Salmon, 2001), and increase positive mood states such as energetic arousal (Reed & Buck 2009; Zschucke et al., 2013).

Mechanisms of Effect of Exercise on Mood

Whilst the research consistently supports a relationship between exercise and mood, the basis of exercise-induced mood change remains poorly understood (Craft & Perna, 2004; Peluso & de Andrade, 2005). Both biological and psychological models attempt to explain the anti-depressant and anti-anxiolytic effects of exercise (Annesi, 2010), with the current state of evidence indicating that a complex interaction of psychological and biological mechanisms is likely to underlie these effects (Craft & Perna, 2004; Strohle, 2009).

A number of biological hypotheses exist including the thermogenic (deVries,1981), endorphin (Ransford, 1982) and monoamine hypotheses (Greist et al., 1979). Of these, the monoamine hypothesis has received the most support (Craft & Perna, 2004). This proposes that exercise is associated with an increased

availability of neurotransmitters, including dopamine, norepinephrine, and serotonin, which are reduced in depression (Craft & Perna, 2004). Research has reported increased levels of these neurotransmitters in plasma and urine after exercise in humans (De Coverley Veale, 1987), whilst animal studies have revealed exercise to be associated with increased serotonin and norepinephrine in a number of brain regions (Dunn et al., 1996). Such findings provide support for the proposed monoamine mechanism of exercise-induced mood changes (Craft & Perna, 2004). However, the evidence supporting this hypothesis has been limited due to methodological difficulties associated with investigating neurotransmitter changes in humans (Craft & Perna, 2004). A prediction of such biological hypotheses is that up to a point, increased exercise will be associated with greater improvement in mood (Dishman, 1995). However, evidence supporting this dose-mood change response has been mixed. Galper, Trivedi, Barlow, Dunn and Kampert (2006) reported a positive linear relationship between exercise dose and changes in mood, however other researchers have reported no such (Annesi & Vaughn, 2011), or non-linear (Annesi, 2003) dose-mood change response.

An alternative hypothesis that has received recent attention is that weight-loss resulting from exercise is associated with improved mood. Research studies, reviews and meta-analyses of modest weight loss interventions (where participants lost approximately 10% of initial weight) have reported improvements in symptoms of depression and anxiety (Blaine, Rodman, & Newman, 2007; Fabricatore et al., 2011; Klem, Wing, Simkin-Silverman, & Kuller, 1997; Osei-Assibey et al., 2010; Palmeira et al., 2010; Rippe et al., 1998; Wing & O Hill, 2001), energy and quality of life (Annesi & Whittaker, 2010; Klem, Wing, McGuire, Seagle, & Hill, 1997; Lofrano-Prado et al., 2009; Miller-Kovach, Hermann, & Winick, 1999; Rippe et al.,

1998; Wright et al., 2012). The basis for such mood improvement and mood symptoms reduction following weight-loss however remains unclear. Some research has revealed a specific relationship between weight loss and mood improvements (Kolotkin, Crosby, Williams, Hartley, & Nicol, 2001; Langer et al., 2009; Messier & Rabasa-Lhoret, 2009), whilst other researchers have not reported significant unique contributions of weight-loss to observed mood changes (e.g., Imayama et al., 2011; Nieman, Custer, Butterworth, Utter, & Henson, 2000), or have reported mood changes associated with only minimal actual weight-loss (Wright et al., 2012). Thus, an initial aim of this study is to test predictions of these biological models and examine the relative contribution of exercise and weight-loss to changes in mood.

Psychological models suggest that exercise interventions lead to changes in a number of psychological variables such as self-esteem, self-efficacy, body image, disordered eating attitudes and social support, and that these changes may be associated with improved mood. In these hypotheses, it is argued that the changes in these psychological variables may be associated with mood change rather than exercise or weight-loss specifically (Annesi, 2010; Wright et al., 2012). That is, the effect of exercise on mood may be mediated by changes in psychological variables. Initial evidence for such a proposal stems from research which has reported mood improvements following exercise interventions, even after controlling for exercise and weight-loss (e.g, Imayama et al., 2011; Perna et al., 1999; Wright et al., 2012). A recent study by Annesi (2009) reported decreased depression following an exercise intervention, but amount of exercise was not a significant predictor of mood change. However, exercise was significant predictor of change in self-efficacy and body image which were reported to be significant predictors of change in mood disturbance (Annesi, 2009). Positive outcomes of exercise interventions on body

image, disordered eating attitudes, self-esteem, self-efficacy and social support have been reported in the literature, although relationships are not well understood (Palmeira et al., 2010; Teixeira et al., 2005). Studies have used various methodologies and designs, with few studies systematically examining the extent to which exercise interventions are effective at changing multiple psychological variables (Langer et al., 2009). Furthermore the literature has focussed primarily on such variables as treatment outcomes associated with exercise interventions and not necessarily viewed them as mediators for mood change (Palmeira et al., 2010). Further research is required to examine whether the effects of exercise is mediated by changes in psychological variables, and this is the primary aim of this thesis.

Mediation refers to the process through which an intervention impacts on mediating variables which have links to change in outcome variables. Thus mediation analysis allows examination into whether changes in mood associated with exercise intervention can be explained through the indirect effects of changes in psychological variables that occur during an exercise intervention (Ranby et al., 2009). We do not claim that these mediators are unique to exercise, but it is assumed that their role in explaining relations between exercise and mood states and symptoms is significant (Feuerhahn, Sonnentag, & Woll, 2012).

An increased understanding of the variables mediating the role between exercise intervention and associated mood changed would allow for interventions to target specific variables to enhance associated mood improvements. A model proposed by Baker and Brownell (2000) suggested improvement in mood may result in increased psychological resources, allowing for the continuation of exercise and healthy eating, and thus the maintenance of weight-loss (Annesi, 2007; Annesi, 2010). This has the potential to not only allow for exercise interventions to improve

mood, but may also result in increased persistence and maintenance with exercise which is currently a primary barrier to the long term success of many individuals attempting weight change (Annesi, 2007). Despite being an emerging field of research, several key psychological variables have been reported to be influenced by exercise. The psychological variables discussed below will be included as potential mediators of the relationships between exercise and mood in this study.

Self-esteem. Self-esteem refers to an individual's global sense of self-worth (Rosenberg, 1965). It has been associated with health, wellbeing and happiness (DuBois, Flay, & Fagen, 2009), with low self-esteem implicated in mood and anxiety disorders (Silverstone & Salsali, 2003). A wealth of support exists regarding improvements in self-esteem following exercise intervention (Desharnais, Jobin, Cote, Levesque, & Godin, 1993; McAuley, Mihalko, & Bane, 1997), with meta-analyses and systematic reviews reporting exercise interventions to have significant beneficial effects on self-esteem in children and adolescents (Ekeland, Hein, & Hagen, 2005), adults (Spence, McGannon, & Poon, 2005) and older adults (Netz, Wu, Becker, & Tenenbaum, 2005). Sorensen, Anderssen, Hjerman, Holme and Ursin (1999) reported a significant increase in self-esteem following an exercise intervention, and further that both exercise and weight-loss were significantly associated with increased self-esteem. Researchers have proposed a role of self-esteem in explaining mood improvements associated with exercise (Folkins & Sime, 1981). However, few studies have specifically investigated the role of self-esteem in the relationship between exercise intervention and mood changes despite calls made in the literature (e.g., Pêtruzzello et al., 1991).

Self-efficacy. Self-efficacy refers to an individual's belief in their own personal capabilities (Bandura, 1997; Craft, 2005; McAuley, White, Rogers, Motl, &

Courneya, 2010). A low sense of self-control or coping efficacy has been associated with anxious responses, negative affect (Luszczynska, Scholz, & Schwarzer, 2005) and low feelings of confidence in one's ability to succeed with task demands (Bandura, 1997). Relationships between self-efficacy and depression have been reported as depressed individuals are characterised by a low sense of efficacy (Bandura, 1997), and increases in self-efficacy are associated with reduced depression (McAuley et al., 2010).

Relationships between exercise and self-efficacy for exercise have been widely reported, with researchers reporting significantly higher levels of self-efficacy in moderately to highly physical active participants relative to sedentary participants (Booth, Owen, Bauman, Clavisi, & Leslie, 2000; Luszczynska, Scholz, & Scwarzer, 2005). Further, improvements in self-efficacy have been reported in participants following exercise interventions (e.g., Annesi, 2007; McAuley et al., 2010). Such research has led to the proposed self-efficacy hypothesis to explain exercise related changes in mood (Landers & Arent, 2001). The self-efficacy hypothesis (Landers & Arent, 2001) suggests that as people exercise they experience increased confidence in exercising, as well as increased physical fitness, which has a positive effect of self-efficacy through promoting perceptions of physical capability and the experience of mastery (Chow & Tsang, 2007). This may function to increase sense of coping ability and result in reducing anxious and depressive symptomology (Chow & Tsang, 2007).

There are relatively few studies examining this question and evidence has been mixed (Craft & Perna, 2004). For example, Craft (2005) reported increased self-efficacy and reduced symptoms of depression following an exercise intervention. Further, Annesi (2012) and Gowans et al. (2001) extended this

reporting changes in self-efficacy following an exercise intention to be significantly correlated with changes in mood including depression and anxiety, adding support to the self-efficacy hypothesis and raising the possibility that changes in self-efficacy may mediate mood changes associated with exercise interventions (Gowans et al., 2001). However, improvements in self-efficacy have not always been reported following exercise interventions. For example, Annesi & Whitaker (2010) reported significant effects of exercise on body image and mood, but not self-efficacy. This might be due to a number of factors including factors associated with the type of exercise and participants success with the prescribed exercise, as well measure of self-efficacy used (e.g., generic vs exercise specific). As a strong link between general self-efficacy and mood and well-being has been established, the current study included a measure of general self-efficacy.

Body image. The important role of body image on mood has received much recent attention (e.g., Palmeira et al., 2010). Body image refers to an individual's body-related self-perceptions and attitudes (Cash, 2004). Satisfaction with body image has been linked to psychological well-being (Stokes, 2003), whilst body image dissatisfaction which involves a negative evaluation of the body perception (Cash, 2004) has been associated with negative mood and wellbeing including depression, anxiety and eating disorders (Kostanski & Gullne, 1998; Stice, Hayward, Cameron, Killen, & Taylor, 2000). It has been reported that body image dissatisfaction partially mediates the relationship between degree of obesity and depression (Freidman, Reichmann, Costanzo, & Mustante, 2002), and that weight loss is associated with reductions in body image dissatisfaction (Carraca et al., 2011; Teixeira et al., 2006). This has led researchers to suggest that exercise and weight-

loss interventions should be developed with a target to improve body-image dissatisfaction (Friedman et al., 2002).

Exercise has been associated with increased body image satisfaction (e.g., Annesi & Whitaker, 2010; Hausenblas & Fallon, 2006). This relationship appears robust, with recent meta-analyses reporting exercisers to have a more positive body image than non-exercisers, and that exercise interventions result in significant improvement in body image (Campbell & Hausenblas, 2009; Hausenblas & Fallon, 2006). Despite the fact that exercise interventions have much potential to influence body image, relatively little research has investigated whether changes in body image are important in explaining changes in mood associated with engagement in an exercise intervention (Langer et al., 2009). Support for this stems from a recent study which reported a mediating role of body image in associations between exercise and internalising mental health problems in a large cross-sectional sample of adolescents (e.g., Monshouwer, Have, van Poppel, Kemper, & Vollebergh, 2013). Additionally Annesi, Unrun and Whitaker (2007) reported significant independent correlations between exercise session attendance and change scores in both body image and mood disturbance in obese women, but they did not examine potential mediation effects in these relationships. Thus as relationships remain not well understood particularly in non-clinical populations, it has been argued that continued study of relations of variables related to exercise interventions is warranted (Annesi et al., 2007).

Disordered eating attitudes. Disordered eating attitudes refers to thoughts about dieting, striving for thinness and preoccupation with food (Jones, Bennett, Olmsted, Lawson, & Rodin, 2001). Disordered eating attitudes, beliefs and behaviours have been associated with increased depression (Braun, Sunday, &

Halmi, 1994), anxiety (Michou & Costarelli, 2011) and eating disorders (Garner, Olmsted, Bohr, & Garfinkel, 1982; Mintz & O'Halloran, 2000).

Whilst little research to date has investigated the effect of exercise interventions specifically on disordered eating attitudes, recent studies by Jordan et al. (2008), Kiernan, King, Stefanick and Killen (2001) and Andradea et al. (2010) have reported healthier eating attitudes such as more flexible dietary restraint and lowered levels of emotional eating following exercise interventions. As such calls have been made for further investigation into the effects of exercise intervention on disordered eating attitudes (Hausenblas, Cook, & Chittester, 2008).

Social support. A final psychological predictor of mood is social support. Social support has been found to be negatively associated with depression (Peirce, Frone, Russell, Cooper, & Mudar, 2000). It has been proposed that social relationships, and the mutual social support that occurs among individuals involved in exercise, has an important role in the effects of exercise on psychological health, including mood (Peluso & de Andrade, 2005). This provides the rationale for the social support hypothesis that is proposed to be one mechanism to explain the mood benefits associated with exercise interventions (Fabricatore et al., 2011; Scully et al., 1998). In support of this hypothesis, a number of researchers have reported improvements in mood following involvement in group exercise (e.g., McAuley, Blissmer, Katula, & Duncan, 2000; Mutrie et al., 2007; Williams & Lord, 2008). Whilst the role of social support in producing weight-loss during weight-loss interventions has received some attention (e.g., Verheijden, Bakx, van Weel, Koalen, & Staveren, 2005), the role of social support as a predictor of improvements in mood following exercise interventions has yet to be fully elucidated. Many exercise interventions include an element of social support, thus the investigation of social

support in understanding mood improvements following exercise intervention is warranted.

Gaps in the Literature

Examining effects of exercise intervention across a range on psychological variables. Whilst exercise interventions have been associated with improvements across a wide range of psychological variables, few studies have concurrently investigated a range of psychological variables and mood in a single study. In addition, a disproportionate amount of attention has been given to the association between exercise interventions and negative mood states, particularly depression and anxiety (Annesi, 2010). However, research suggests that increases in positive moods are important predictors in maintenance and continuance of exercise interventions indicating this to be an important area for further investigation (Annesi, 2010).

Examining the relative contribution of exercise, weight loss and psychosocial variables to mood change following exercise interventions. Despite recent reviews reporting beneficial effects of exercise interventions on mood, little research has examined possible mechanisms of this mood change. As summarised above, several psychological variables are associated with both mood and exercise, including self-esteem, self-efficacy, social support, body image and disordered eating attitudes, but few studies to our knowledge have examined the predictive power of such changes regarding changes in mood following an intervention. Furthermore recent models are proposing that these psychological variables may mediate the relationship between exercise and mood, however this has received relatively little investigation (Craft & Perna, 2004). Increased understanding into the mechanisms behind mood improvements has significant implications for the design

and development of exercise interventions to maximise mood changes and promote maintenance of exercise behaviours and weight change (Langer et al., 2009).

Examining effects on non-obese populations, non clinical populations. The majority of research into exercise interventions has focussed on morbidly obese and clinical samples, however it has been proposed that there is a need to investigate relationships among non-obese and non-clinical samples as this may be more typical of the population engaging in exercise interventions (Annesi & Whitaker, 2010; Imayama et al., 2011). As such the current study aims to investigate relations of exercise, weight loss, mood and psychological variables in women participating in a 12 week gym based weight-loss intervention.

Summary, Rationale and Aims

Important relationships have been reported between exercise, weight-loss, mood and psychological variables such as self-esteem, self-efficacy, body image, disordered eating attitudes and social support (Langer et al., 2009). Whilst compelling evidence indicates positive mood changes following engagement in exercise interventions (Fabricatore et al., 2011), there exists a clear need to develop a better understanding of what is leading to improvements in mood associated with engagement in exercise interventions (Annesi & Whitaker, 2008; Blissmer et al., 2006; McAuley et al., 2010). Recent research findings indicate that psychological variables may mediate the relationship between mood and exercise (Gowans et al., 2001), but this has received little attention to date and requires further investigation. Thus systematic investigation into the relative changes in exercise, weight loss, and psychological variables such as self-esteem, self-efficacy, body image, disordered eating attitudes and social support following exercise interventions is required

(Annesi & Whitaker, 2008; Berger, Darby, Owen, & Carels, 2010; Palmeira et al., 2010; Ross et al., 2009).

The purpose of this study is to investigate the effect of an exercise intervention (a 12 week 'Get Foxy Challenge' (GFC)) on mood (specifically positive mood and energy, and feelings of depression and anxiety) in a sample of healthy adult women. The current study has three specific aims; to investigate the effect of the GFC on the women's mood and psychological wellbeing; to investigate the relative importance of change in exercise, weight-loss and psychological variables in predicting changes in mood following the GFC, and to investigate whether changes in social support, self-esteem, self-efficacy, disordered eating attitudes and body image mediate the relationship between mood changes and exercise intervention (GFC).

Hypotheses

Based on the evidence suggesting a range of psychological and mood improvements following exercise interventions (Fabricatore et al., 2011), it was hypothesised that the GFC would be associated with significant improvements across psychological and mood variables including depression, anxiety, energy, positive mood states, body image, disordered eating attitudes, self-esteem, self-efficacy and social support.

Secondly, it was hypothesised that changes in psychological variables (self-efficacy, self-esteem, social support, body image and disordered eating attitudes) would predict change in mood (depression, anxiety and positive mood states) over and above that of change in exercise across both GFC and control participants.

Thirdly, it was hypothesised that change in social support, self-efficacy, self-esteem, disordered eating attitudes and body image would significantly mediate the

relationship between group status (GFC Exercise Group vs Controls) and mood changes.

Method

Participants

Participants were 57 healthy women aged 18 to 62 with a mean age of 31.2 years (standard deviation (SD) (13.10) and weight of 68.22 kg (14.68). The GFC group (n=17) was comprised of adult women enrolled in the GFC, a 12 week gym-based exercise intervention developed and run by Fernwood Fitness Centres. Participants were recruited from two consecutive GFCs over a six month period. Participants were recruited by on commencing the GFC. The control group (n=40) was comprised of a community and university sample and was recruited through advertisements. First year psychology students at the University of Tasmania (UTAS) were offered course credit for participation. Characteristics of the participants are shown in Table 1.

Participation was limited to females because the GFC is run through a female only fitness centre. A total of 98 participants (GFC; n=30; Control n=68) were enrolled in the current study and completed the first survey, however attrition resulted in a total of 57 participants completing the study (60%). Participants completing the study received a $20 gift-voucher and were entered in the draw to win an IPAD. The study protocol was approved by the Tasmanian Social Science Human Research Ethics Committee (HREC approval number H0012719) (see Appendices A-D).

Procedure

After providing informed consent (Appendices E and F), all participants completed an online survey (comprised of the dependent measures listed below) at four time points over a period of 16 weeks: at baseline (during the first week of the GFC for GFC participants), 6 weeks, 12 weeks (immediately after GFC completion) and 16 weeks (4 weeks after GFC) post-baseline. The baseline survey included a general demographic and medical history questionnaire (Appendix G). Data were collected over two 16 week periods in six months during 2012-2013 using LimeSurver Version 2.0, an online survey.

Get Foxy Challenge Condition (GFC)

The GFC is run by Fernwood Fitness Centres and is a semi-structured 12-week group programme which incorporates both individual and group-based exercise and dietary modification to increase exercise and promote healthy weight-loss. Participants in the GFC attend two hours of structured exercise (one individual and one group personal training session) per week, and one hour a fortnight of group nutritional education. Participants are encouraged to engage in extra exercise outside of the structured sessions. Participants are weighed and measured fortnightly and record all their exercise in a journal provided. The GFC encourages the use of social support through facilitating participants to support each other to reach exercise and weight-loss goals. Participants are grouped into small groups with whom they share a guided weekly exercise session and a team approach is fostered through the use of team exercise and weight-loss targets and rewards.

Dependent Measures

Weight. GFC participant's body weight in kilograms (kg) was measured using a standardized set of electronic digital scales. Participants self-reported their recorded body weight ratings at the four assessment time points (See Appendix H). Body weight was self-reported by control group participants, who were asked to provide their weight in kg as measured on the same day as completing the survey.

Exercise. Exercise was measured as minutes per week engaged in moderate to vigorous physical exercise, as assessed by a questionnaire modified from Ainsworth et al. (2000) International Physical Activity Questionnaire (IPAQ) (Appendix I). The IPAQ is a validated and widely used self-report instrument developed to allow for internationally comparable data on physical activity (Craig et al., 2003). The total amount of minutes per week participants spent engaging in all types of exercise recorded was summed to provide a total weekly minutes of exercise score which was recorded at the four assessment time points.

Mood.

The depression, anxiety and stress scale - 21 (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 was used to provide a measure of state levels of depressed, anxious and stressed mood (Appendix J). The DASS-21 is a 21 item self-report instrument that has been well validated and is widely used as a brief measure of the severity of depressed, anxious and stressed mood in non-clinical samples (Henry & Crawford, 2005; Siamak & Bahram, 2007). At each of the four surveys participants were asked to rate the extent to which they experienced symptoms based on the past week. Total scores for each subscale range from 0-21, with higher scores associated with greater symptoms of Depression, Anxiety and Stress.

UWIST mood adjective checklist (UMACL; Mathews, Jones, & Chamberlain, 1990). Positive mood state was assessed by the UMACL (Appendix K). The UMACL is comprised of 29 items that fall into four subscales reflecting different aspects of mood state: Hedonic Tone (happy, sad); Tense Arousal (tense, relaxed), Energetic Arousal (alert, tired), and Anger (angry, irritated). The psychometrics of the UMACL are well established (see Mathews et al., 1990). Participants rate to what extent they have experienced the 29 mood states over the past week on a 5 point scale from not at all to extremely. We examined Hedonic Tone and Energetic Arousal as indices of positive mood, with scaled scores ranging from 0-32 on each of the subscales.

Psychological Variables.

Social support. A modified version of the Berlin Social Support Scale (BSSS; Schwarzer & Schulz, 2000) (Appendix L) was used to measure participant's social support. The scale comprises five measures of cognitive as well as behavioural aspects of social support including, perceived support, need for support, support seeking and perceived support provided, as well as satisfaction of support received. The BSSS is comprised of 16 items and asks participants to rate on a 4 point Likert scale. Responses range from 0- 64, with higher responses reflecting higher levels of social support (Schulz & Schwarzer, 2003).

Disordered eating attitudes. Disordered attitudes to eating were examined using the EAT-26 (EAT; Garner & Garfinkel, 1979) (Appendix M). This is a 26-item self-report questionnaire designed to identify abnormal eating habits, attitudes and behaviours and concerns about weight. The EAT-26 is the most widely used standardised questionnaire to assess risk of disordered eating (Osei-Assibey et al., 2010). Participants record their agreement with statements about weight and food,

such as ''I feel that food controls my life'' and ''I find myself preoccupied by food'', on a 6-point scale anchored. Higher total EAT scores indicate disturbed eating attitudes, behaviour and concern with weight, while a score of 20 or more may indicate the presence of an eating disorder. The EAT-26 has acceptable criterion-related validity and high internal consistency with reported alpha coefficients in excess of 0.94 (Garner et al., 1982).

Body image. Body image dissatisfaction was evaluated by the Body Shape Questionaire-8c (BSQ-8c; Cooper, Taylor, Cooper, Fairburn, & Phil, 1987; Evans & Dolan, 1993) a measure of body shape concern (Appendix N). The BSQ-8c is an 8 item instrument with a 6 point Likert scale used to measure affective, cognitive, and behavioural dimensions of body image, especially the experience of, and preoccupation with 'being fat'. The BSQ has been reported to be a reliable and valid measure of body image with good test-re-test reliability (.88) and concurrent validity with other body image measures (Brown, Cash, & Mikulka, 1990; Rosen, Jones, Ramirez, & Waxman, 1996). Scores are summed to provide a total score ranging from 8-46, where higher values represent greater preoccupation with body shape and image concerns, indicating higher body image dissatisfaction.

Self-efficacy. The Generalised Self-Efficacy Scale (GSE; Schwarzer & Jerusalem, 1995) is a measure of self-efficacy which examines perceived ability in overcoming difficulties in 10 situations using a 4 point Likert scale (e.g., "When I am confronted with a problem, I can usually find several solutions") (Leganger, Kraft, & Roysamb, 2000). Scores are summed to provide a total score, with scores ranging from 10-40 and higher scores reflecting greater self-efficacy (Appendix O). High reliability and construct validity have been reported, with cronbach alphas from .86 to .94 reported (Luszczynska et al., 2005).

Self-esteem. Rosenberg's (1965) Self-Esteem Scale (SES) is a widely used measure of general self-esteem with acceptable validity (Furnham, Badmin, & Sneade, 2002) and high test re-test reliability (.88) reported (Robins, Hendin, & Trzeniewski, 2001) (Appendix P). The SES is a 10 item scale which asks participants to rate responses on a 4 point Likert scale. Scores range between 10 and 40 with higher scores indicating higher self-esteem.

Statistical Analysis

Analysis of GFC intervention effects. To investigate any pre-existing differences between the groups, baseline values of demographic variables and dependent measures were analysed for differences between the GFC and control groups in a series of one way analysis of variances (ANOVAs) and Chi-square tests. To investigate any changes from baseline to the end of the GFC programme, a series of 2 [Group: GFC/Control] × 2 [Time: Week 1/Week 12] repeated measures ANOVAs were conducted for each dependent measure. Weeks 6 and 16 Time data were not included in analyses due to the low survey completion rate at these time points which resulted in these time points being underpowered and providing no additional information. Sidak post-hoc tests were used to examine any pairwise comparisons in interactions. SPSS (Version 21, SPSS, Inc., Chicago, IL) was used for data analysis. The significance level for two-sided hypothesis testing was set at .05 and partial eta squared effect sizes are reported.

Regression analysis. To investigate the relative contribution of exercise, weight loss and psychological factors associated with changes in mood, four hierarchical multiple regressions were conducted using change scores (week 1 to week 12) for the four dependent measures of mood (Depression, Anxiety, Hedonic Tone, Energetic Arousal) as the outcome variable. Predictor variables entered into

each of these regressions were; exercise change, weight loss change, and psychological (EAT change scores and Body Image change scores) variables that demonstrated the largest change across the GFC programme. Predictor variables were entered simultaneously. Self-efficacy, social support and self-esteem were not included as predictors as they did not demonstrate significant change relating to the GFC intervention. Alpha significance level was set at <.05, with no bonferroni adjustments as recommended by Perneger (1998).

Mediation model design and analysis. To further investigate whether psychological variables mediated the relationship between exercise group and mood, a mediation analysis was conducted in separate analyses for the four mood dependent measures (Depression, Anxiety, Hedonic Tone, Energetic Arousal) with group as the predictor variable and EAT score at week 12 as the mediating variable. As EAT change was the only variable shown to significantly predict mood changes associated with the GFC, EAT was the only mediator tested in the four single mediation analyses. All mediation analysis controlled for differences in EAT scores at week 1 by including week 1 EAT scores as covariates in the analyses.

The PROCESS macro for SPSS (Hayes, 2012) was used to test for the mediation effect of EAT change on each mood outcome variable. This model uses three equations to estimate four regression coefficients. The total effect of the mediation model considers the influence of the independent variable (X) on the dependent variable (Y) independently of the mediator (M). This is the *c* pathway and is represented in the following equation $Y = i_1 + cX + e_1$. The direct effect considers the effect of X on Y in the context of M on Y; the *c'* pathway, represented by the equation $Y = i_2 + c'X + bM + e_2$. The *a* path is the effect of the intervention X on the mediator M. The *b* path is the relationship of mediator *M* to outcome *Y*. The product

of the *a* and *b* paths, *ab*, is the mediated effect. The indirect effect pathway looks at the effect of X on Y via M, which is located causally between X and Y. It can be conceptualised as the product of the '*a*' pathway (the effect of X on M) and the '*b*' pathway (the effect of M on Y in the context of X on Y). It is the part of the total program effect transmitted through the mediator (see Figure 1). Statistical significance of the *ab* estimate is evidence of mediation.

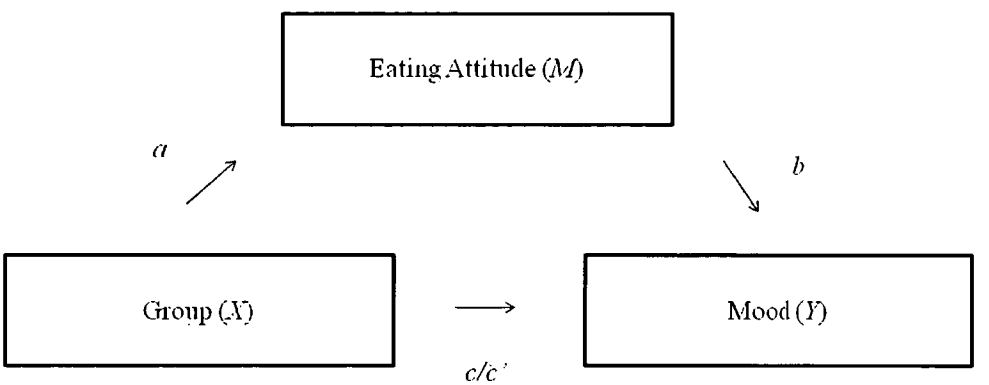


Figure 1. Model of mediation analysis.

Of most interest in mediation analyses is the indirect effect. This effect can be described as the unit change in the outcome variable caused by a one unit increase in the independent variable via the mediator. This effect can be conceptualised as the total effect minus the direct effect, $c - c'$. Alternatively, it has been shown that this is algebraically identical to the product term *a*b* (MacKinnon & Dwyer, 1993; MacKinnon, Warsi, & Dwyer, 1995). When calculating indirect effects using the product of coefficients approach, it ordinarily must be assumed that the product of *a*b* is normally distributed. However in reality, it is generally positively skewed and kurtotic (Preacher, Rucker, & Hayes, 2007). By resampling using bootstrapping as is done in the PROCESS macro, confidence intervals can be developed around the

indirect effect, with no assumptions about the shape of the sampling distribution. This approach has been established as best-practice for mediation analyses (Hayes, 2012). It is superior to the causal steps approach (Baron & Kenny, 1986; Judd & Kenny, 1981) and Sobel testing as it directly probes the indirect pathway (MacKinnon, Fairchild, & Fritz, 2007).

Results

Unless otherwise specified, the reported results include all participants for whom data were available at week 1 and week 12 (N=57). In order to maintain power of the primary analysis of intervention effect, the primary analysis was limited to week 1 and week 12. This was due to the low survey completion rate at weeks 6 and 16.

Participant Characteristics

A series of one-way between group ANOVAs and Chi-square tests were conducted to compare group characteristics at week 1. Only participants who completed surveys at week 1 and week 12 were included in analyses.

Demographics. As shown in Table 1, participants in the GFC group and control group did not significantly differ at week 1 on years of education, F (1,56) = .12, MSE = .44, p=.73, η_p^2<.01, relationship status (married; single), $X^{(1)}$ = .49, p=.49, or experience of recent stress, $X^{(1)}$ = .07, p=.79. A chi-square test revealed a significantly higher percent unemployed in the GFC group relative to the control group, $X^{(1)}$ = 4.97, p=.03. Participants in the GFC group were significantly older than control group F (1,56) = 18.34, MSE = 2650.66, p <.01, η_p^2=.25. The GFC and control groups did not differ on baseline measures for any mood or psychological variable.

Table 1

Participant Characteristics at Week 1 and Week 12

Variable	GFC Group		Control Group	
	Week 1 Mean *(SD)*	Week 12 Mean *(SD)*	Week 1 Mean *(SD)*	Week 12 Mean *(SD)*
Age (years)	40.05 (12.19)		26.44 (11.03)	
% Married	76%		44%	
Education (yrs)	15.63 (2.27)		15.78 (1.75)	
% Employed	88%		97%	
Weight (kg)	75.91 (17.27)	72.28 (13.16)	63.61 (12.13)	63.58 (12.28)
Weekly Exercise Score	420.53 (209.67)	376.23 (180.49)	255.09 (261.29)	205.68 (223.27)
Mood Variables				
Depression	3.19 (3.74)	1.42 (2.00)	2.78 (3.82)	3.19 (3.73)
Anxiety	2.00 (2.85))	.62 (1.09)	2.66 (3.62)	3.22 (3.80)
Hedonic Tone	21.64 (5.97)	25.42 (3.20)	22.90 (5.32)	22.51 (5.65)
Energetic Arousal	18.35 (6.95)	24.17 (4.65)	18.12 (5.58)	16.76 (5.90)
Psychological Variables				
Social Support	51.17 (6.87)	50.76 (5.98)	51.19 (5.60)	50.78 (5.87)
Self-Efficacy	31.47 (3.82)	33.82 (3.64)	29.83 (5.16)	31.12 (4.76)
Self-Esteem	18.35 (6.85)	19.47	17.07 (4.55)	16.80 (5.13)
EAT	10.71 (8.56)	7.29 (6.72)	7.37 (9.19)	8.09 (10.85)
Body Shape Questionnaire	28.42 (7.95)	23.65 (9.95)	26.68 (10.16)	25.29 (8.75)

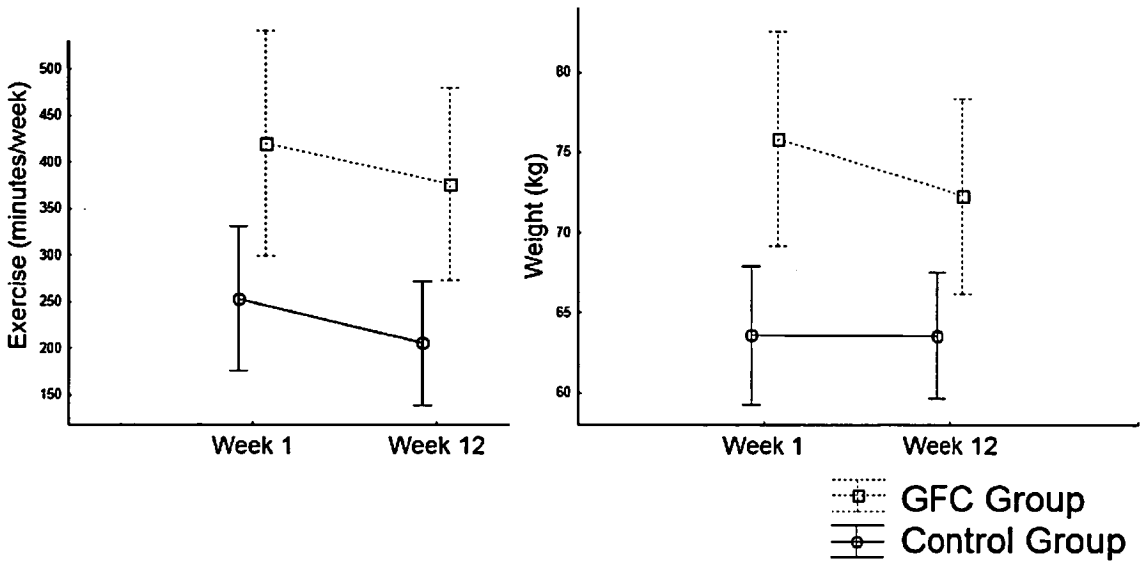
Note: EAT= Eating attitudes test; *SD* = standard deviation

GFC Intervention Effects

To investigate effects of the GFC intervention a series of 2 [Group: GFC; Control] × 2 [Time; Week 1; Week 12] repeated measures ANOVAs were conducted with Sidak Post-hoc tests.

Weight. Figure 2 shows the weight change from week 1 to 12 in the GFC group and the control group. Significant main effects of time, $F(1,56)= 14.37$, $MSE=80.28$, $p<001$, $\eta_p^2=.20$ and group, $F(1,56)=7.76$, $MSE=2625.88$, $p<.01.$, $\eta_p^2= .12$ were moderated by a significant Time x Group interaction, $F(1,56)=13.87$, $MSE =77.52$, $p<.001.$, $\eta_p^2= .20$. Post-hoc tests revealed that although the GFC group weighed significantly more at week 1 ($p<.01$) and week 12 ($p=.02$), the GFC group significantly decreased weight from week 1 to week 12 ($p<.001$), but there was no significant weight change for the control group ($p=.95$).

Exercise. As shown in Figure 2, the GFC group engaged in significantly higher levels of exercise at week 1 and week 12 than the control group as revealed by a significant main effect of group, $F(1,56)=13.48$, $MSE =684602.76$, $p<.01.$, $\eta_p^2=.19$ No significant main effect of time, $F(1,56)=.91$, $MSE =51020.476$, $p=.34.$, $\eta_p^2=.02$, or Time × Group interaction, $F(1,56)=.00$, $MSE =76.13$, $p=.97$, $\eta_p^2= <.01$ were reported for exercise.



* Values are the mean. Error bars represent 95% confidence Intervals

Figure 2. Change in weight and exercise observed during the 12 weeks in the GFC and control groups.

Psychological variables.

Social support. No significant main effects of time, F (1, 56) = .26, MSE=4.10, p=.61, η_p^2=.01, group, F (1, 56) = .00, MSE=.01, p=.399, η_p^2<.01, or Time × Group interaction F (1, 56) =.00, MSE=4.95E-005, p=.99, η_p^2<.01 were revealed for Social Support (see Figure 3).

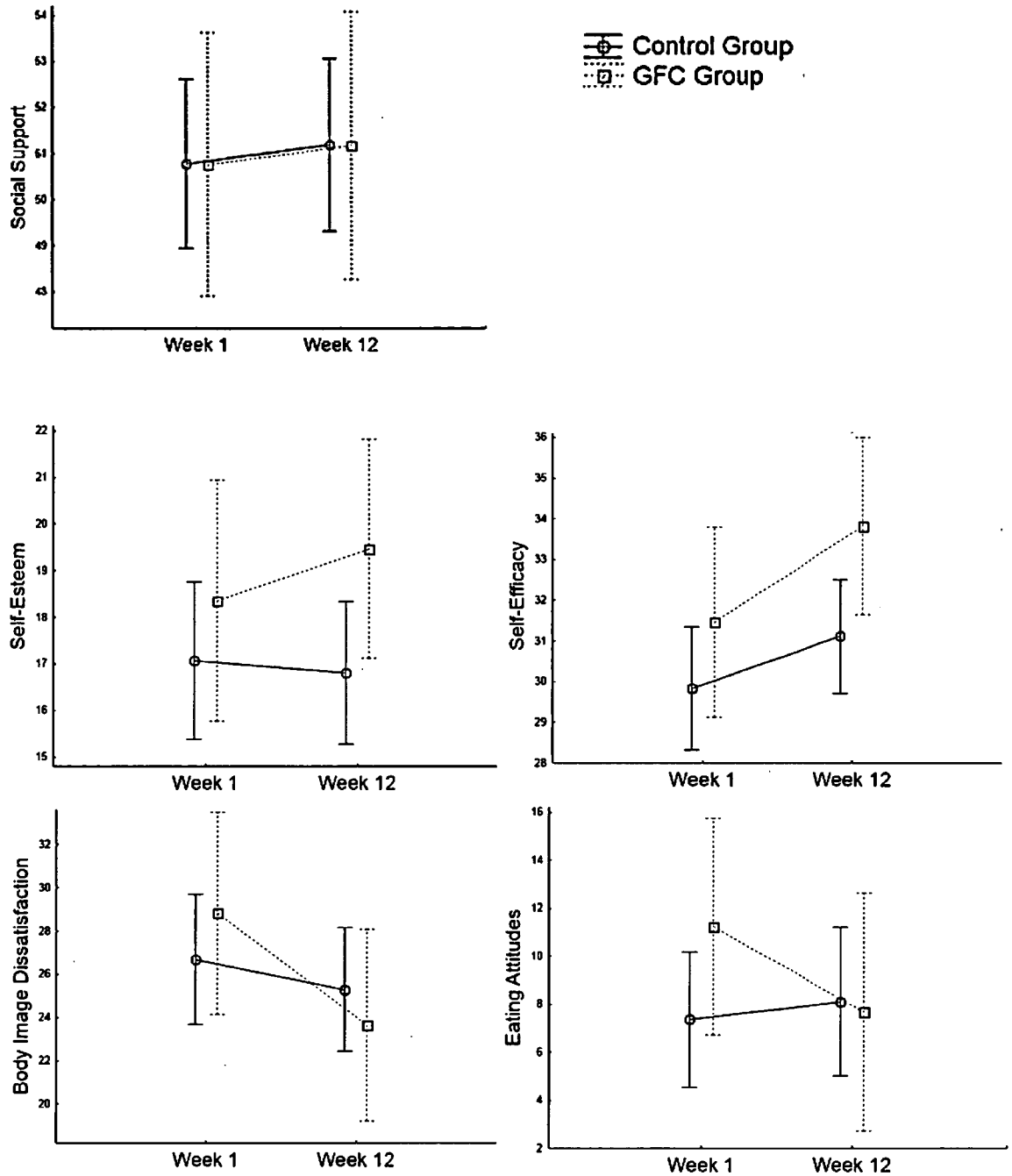
Self-esteem. No significant main effects of time, F (1, 55) = .53, MSE=4.24, p=.47, η_p^2=.01, group, F (1, 55) = .2.13, MSE=.92.99, p=.15, η_p^2=.04, or Time × Group interaction, F (1, 55) =.1.45, MSE=11.59, p=.23, η_p^2=.03 were revealed for Self-esteem (see Figure 3).

Disordered eating attitudes (EAT). No significant main effects of time, F (1,56) = 2.29, MSE= 47.03, p=.14, η_p^2 = .04, or group, F (1,56) = .27, MSE= 42.33, p =.61, η_p^2 <.01 were reported. As shown in Figure 3, a significant Time × Group interaction, F(1, 56) = 5.09, MSE= 109.09, p=.03, η_p^2 = .09 was revealed. Post-hoc tests indicated a significant decrease in scores on the EAT at week 12 relative to week 1 in the GFC group (p=.02), but not in the control group (p=.47). The GFC

and control groups did not differ significantly on the EAT at week 1 (p=.19), or week 12 (p=.78).

Body Image. A significant main effect of time, F (1, 56) = 10.69, MSE= 259.10, p<.01, η_p^2 = .16, but not group, F (1, 56) = .01, MSE= 1.47, p=.92, η_p^2 = <.01 was reported for body image. These were moderated by trend towards a significant Time × Group interaction, F (1, 56) = 3.57, MSE= 86.13, p=.06, η_p^2 = .06 (see Figure 3). Post-hoc tests indicated a significant decrease in body image dissatisfaction from week 1 to week 12 in the GFC group (p<.01) but not the control group (p=.21). The GFC and control groups did not differ significantly on body image scores at week 1 (p=.44) or week 12 (p=.53).

Self-efficacy. As can be seen in Figure 3 self-efficacy increased significantly from week 1 to week 12 in both groups, F (1, 56) = 9.91, MSE= 79.86, p<.01, η_p^2 =.15. No significant main effect of group, F (1, 56) = .3.22, MSE=113.33, p=.08, or significant Time × Group interaction, F (1, 56) =.84, MSE= 6.76, p=.36, η_p^2 =.02 were revealed.



* Values are the mean. Error bars represent 95% confidence Intervals

Figure 3. Group differences on psychological variables at week 1 and week 12.

Mood Variables.

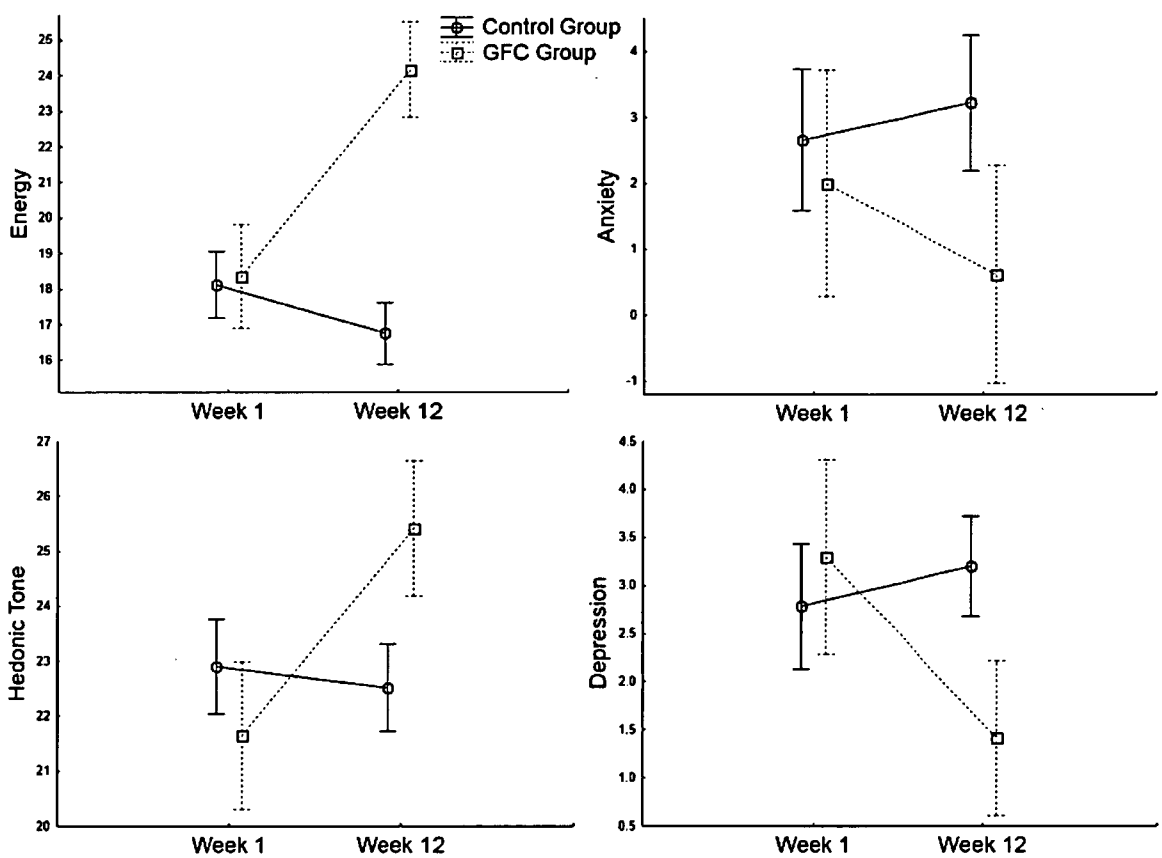
Depression. There was no significant effect of group, F (1,56) = .38, MSE = 9.69, p= .54, η_p^2 = .01, and a trend for a time effect, F (1,56) = 3.76, MSE = 12.94, p=.06, η_p^2 = .06, was moderated by a significant Time × Group interaction, F (1,56) = 9.20, MSE = 31.70, p<.01, η_p^2 = .14 (see Figure 4). Post-hoc tests revealed a significant decrease in depression from week 1 to week 12 in the GFC group (p<.01), but not in the control group (p=.31). A trend towards significantly lower depression in the GFC group relative to the control group at week 12 (p=.07) but not week 1 (p=.67) was also revealed.

Anxiety. No significant main effects of time, F (1,56) =1.53, MSE = 3.81, p=.22, η_p^2 = .03, or group, F (1,56) = 3.03, MSE = 60.89, p= .09, η_p^2 = .05 were reported for anxiety. A significant Time × Group interaction, F (1,56) = 8.66, MSE = 21.57, p<.01, η_p^2 = .14 revealed a significant reduction in anxiety in the GFC group between week 1 and week 12 (p=.01), whilst no significant changes in anxiety occurred for the control group (p=.11) (see Figure 4). Further, there were no significant differences in anxiety between the GFC group and control group at week 1 (p=.52), but significantly less anxiety was reported in the GFC group at week 12 (p=.01)

Hedonic tone. There was no significant effect of group, F (1,56) = .35, MSE = 16.24, p= .55, η_p^2 = .01, but a significant main effect of time, F (1,56) = 6.68, MSE = 68.42, p=.01, η_p^2 = .11, was moderated by a significant Time × Group interaction, F (1,56) = 10.13, MSE = 103.73, p<.01, η_p^2 = .15 (see Figure 4). Post-hoc tests revealed a significant increase in hedonic tone from week 1 to week 12 in the GFC group (p<.01), but not in the control group (p=.58). Significantly higher hedonic tone

in the GFC group relative to the control group at week 12 (p=.05) but not week 1 (p=.43) was also revealed.

Energetic Arousal. Significant main effects of time, F (1,56) = 6.39, MSE = 119.39, p=.01, η_p^2 = .10, and group, F (1,56) = .7.27, MSE = 351.77, p= .01, η_p^2 = .12 were moderated by a significant Time × Group interaction, F (1,56) = 16.61, MSE = 310.57, p<.001, η_p^2 = .23 as shown in Figure 4. Post-hoc tests revealed a significant increase in energetic arousal from week 1 to week 12 in the GFC group (p<.001), but not in the control group (p=.16). The GFC group reported significantly higher energetic arousal than the control group at week 12 (p<.001), whilst no significant differences in energetic arousal between groups was revealed at week 1 (p=.89).



* Values are the mean. Error bars represent 95% confidence Intervals

Figure 4. Group differences across mood variables at week 1 and week 12.

Multiple Regression Analyses: Predictors of Mood Change Associated with GFC Intervention.

As Body Image and EAT significantly changed during the GFC, these variables were included alongside Exercise and Weight as predictor variables in four hierarchical multiple regression analyses which employed the four mood measures as outcome variables across both groups. These regressions examined the relative contribution of changes in Exercise, Weight, EAT and Body Image on changes in mood from week 1 and week 12, with simultaneous entry of predictor variables. All models accounted for a significant portion of the variance in change in mood, see Tables 2, 3, 4 and 5. Collinearity of predictors was assessed using correlational analyses, and few significant correlations were found between predictor variables (see Appendix Q).

Depression. Analysis revealed change scores from week 1 to week 12 in Exercise, Weight, EAT and Body Image accounted for a statistically significant 10% of the variance of the change in depression, see Table 4. EAT change was the only significant predictor of change in depression across time.

Table 2

Multiple Regression Analysis for the Prediction of Depression Change During the GFC

Model Variable	β	R	R^2	Adjusted R^2	F/t	*p*
Δ Depression (*N*=57)		.41	.17	.10	2.55	.05
Δ Exercise	-.09				-.76	.45
Δ Weight	-.05				-.33	.72
Δ EAT	.32				2.09	.04

Δ Body Image	.13				.79	.43

Anxiety. Analysis revealed change scores from week 1 to week 12 in Exercise, Weight, EAT and Body Image accounted for a statistically significant 10% of the variance of the change in anxiety, see Table 3. Change in EAT was revealed to be the only significant predictor of change in anxiety.

Table 3

Multiple Regression Analysis for the Prediction of Anxiety Change During the GFC

Model Variable	β	R	R^2	Adjusted R^2	F/t	*p*
Δ Anxiety (*N*=56)		.41	.17	.10	2.55	.05
Δ Exercise	-.09				-.76	.45
Δ Weight	-.05				-.33	.74
Δ EAT	.32				2.09	.04
Δ Body Image	.13				.79	.43

Hedonic tone. Analysis revealed that change scores from week 1 to week 12 in Exercise, Weight, EAT and Body Image together accounted for a statistically significant 26% of the variance of the change in hedonic tone. As shown in Table 4, Change in Weight and EAT across the GFC intervention significantly predicted change in hedonic tone, with change in Exercise and Body Image predicting hedonic change tone at trend level.

Table 4

Multiple Regression Analysis for the Prediction of Hedonic Tone Change During the GFC

Model Variable	β	R	R^2	Adjusted R^2	F/t	*p*
Δ Hedonic Tone (*N*=57)		.56	.32	.26	6.00	<.01
Δ Exercise	-.21				-1.81	.08
Δ Weight	-.29				-2.32	.02
Δ EAT	-.54				-3.94	<.01
Δ Body Image	.27				1.87	.07

Energetic arousal. Analysis revealed change scores from week 1 to week 12 in Exercise, Weight, EAT and Body Image accounted for a statistically significant 18.3% of the variance of the change in energetic arousal in GFC participants, see Table 5. Again EAT was revealed as the only significant predictor of change in energetic arousal.

Table 5

Multiple Regression Analysis for the Prediction of Energetic Arousal Change During the GFC

Model Variable	β	R	R^2	Adjusted R^2	F/t	*p*
Δ Energetic Arousal (N =57)		.49	.24	.18	4.14	<.01
Δ Exercise	-.11				-..91	.36
Δ Weight	-.18				-1.40	.16
Δ EAT	-.43				-2.98	<.01
Δ Body Image	-.003				-.02	.99

Mediation Analysis

To test whether EAT change mediated the relationship between group and mood, a mediation analysis was conducted in separate analyses for the four mood dependent measures (Depression, Anxiety, Hedonic Tone, Energetic Arousal) with group as the predictor variable and EAT week 12 score as the mediating variable. To control for influence of baseline values, EAT scores at week 1 were included as a covariate.

Data screening. The distribution of the data was explored with Kolmogorov-Smirnov tests of normality on all outcome variables. The results of these tests were significant for some of the outcomes (see data file for full list). However, according to Tabachnick and Fidell (2007) regression analyses are relatively robust to violations of normality, hence no corrections were made.

Total effect. Table 6 shows the total effect, or *c* pathway of Group on all of the outcome variables. It shows that Group condition was a good predictor of scores

on all outcome variables (p<.05), with 95% CI intervals around this effect not including zero in their range.

Direct effect. Similarly it can be seen that the direct effect or c' pathways of Group condition in the context of EAT change on each outcome was significant (p<.05) and 95% CI around these effect not including zeros, see Table 7.

Indirect effect. As seen in Table 8, the indirect effect of Group on the outcome variables of depression, anxiety and hedonic tone via the mediator EAT change were significant. The indirect effect of Group on the outcome variables of energetic arousal via the mediator EAT change was not significant. A bootstrapping approach was used to generate 95% CIs for the indirect effect, and as can be seen in depression, anxiety and hedonic tone outcome variables does not include zero. Thus Group effect on hedonic tone, depression and anxiety at week 12 (controlling for hedonic tone, depression and anxiety at week 1, respectively) is significantly mediated by change in EAT. This indicates that the GFC intervention resulted in a decrease in participants disordered eating attitudes which in turn, resulted in decreased scores on negative mood measures including depression and anxiety, and increased scored on the positive mood measure of hedonic tone.

Table 6

Total Effect of Group Condition on Outcome Variables

	B	SE	t	*p*	Lower 95% CI	Upper 95% CI	R^2
Depression	-2.14	.62	-3.41	<.01	-3.41	-.88	.66
Anxiety	-2.15	.64	-3.40	<.01	-3.43	-.89	.69
Hedonic Tone	3.84	1.17	3.26	<.01	1.47	6.19	.48

Energetic Arousal	7.26	1.49	4.84	<.001	4.25	10.26	.44

Note: R^2 values are for the complete model which includes the covariates Week 1 Depression, Anxiety, Hedonic Tone and Energetic Arousal. N =57 except for Anxiety (N =56).

Table 7

Direct Effects of Group Condition on Outcome Variables

	c'	SE	t	*p*	Lower 95% CI	Upper 95% CI	R^2
Depression	-1.72	.63	-2.74	<.01	-2.98	-.46	.63
Anxiety	-1.72	.64	-2.68	<.01	-3.02	-.44	.65
Hedonic Tone	3.26	1.19	2.73	<.01	.86	5.66	.45
Energetic Arousal	6.37	1.53	4.16	<.001	3.29	9.44	.39

Note: R^2 values are for the complete model which includes the covariates of Week 1 Depression, Anxiety, Hedonic Tone and Energetic Arousal. *c'* represents the direct effect of Group condition on each outcome in the context Eating Attitude change effecting the outcome. N =57 except for Anxiety (N =56).

Table 8

Indirect Effect of Group on Outcomes via Disordered Eating Attitude Change

		Bootstrapped	Bootstrapped 95% CI	
Measure	*ab*	*SE*	Lower	Upper
Depression	-.42	.25	-1.21	-.09
Anxiety	-.43	.29	-1.19	-.04
Hedonic Tone	.58	.44	.00	1.92
Energetic Arousal	.89	.59	-.00	2.46

Note: Week 1 Depression, Anxiety, Hedonic Tone and Energetic Arousal were included in the analyses but are omitted in the table to enhance readability. *ab* represents the product of the *a* and *b* coefficients. N =57 except for Anxiety (N =56).

Discussion

As expected, significant improvements in weight, depression, anxiety, hedonic tone, energetic arousal and disordered eating attitudes, and a trend towards significant change in body image, were found in the GFC group following engagement in the 12 week GFC. There were no significant changes observed in self-efficacy, self-esteem or social support following the GFC. The most significant and consistent predictor of changes in depression, anxiety and hedonic tone were improvements in disordered eating attitudes. A mediation analysis confirmed that changes in disordered eating attitudes mediated the relationship between group status (GFC or control) and mood.

Effects of the Get Foxy Challenge

Individuals who participated in the GFC for 12 weeks displayed significantly greater exercise across all time points and achieved significant weight loss relative to controls. Although the GFC group remained significantly heavier across both time points, and the weight loss achieved by participants in the GFC was relatively modest (mean weight-loss=3.63 kg), a growing body of literature exists supporting the notion that even modest weight loss is associated with a range of positive health implications (Goldstein, 1992; Kanders & Blackburn, 1992). Exercise is an important component of effective weight-loss and is reported to be particularly critical in weight-loss maintenance (Perri, Sears, & Clark, 1993; Wu, Gao, Chen, & van Darn, 2008).

The wide variety of improvements in mood and psychological variables experienced by participants in the GFC adds to the existing literature reporting beneficial effects of exercise interventions on the psychological profiles of participants (Annesi & Whittaker, 2008; Faulconbridge et al., 2009; Imayama et al., 2011). The improvements such as decreased anxiety and depression and increased positive mood states and energetic arousal are particularly important because these changes may contribute to an individual's willingness and motivation to maintain positive exercise and dietary changes which will allow for weight loss maintenance (Annesi, 2007; Baker & Bronwell, 2000; Kayman, Bruvold, & Stern, 1990; Palmeira et al., 2010; Schwartz & Brownell, 2004). The observed improvements in indices related to disordered eating attitudes and body image are also likely to contribute further to reinforcement of positive behaviours and long-term weight-loss maintenance (Annesi & Whittaker, 2010).

It is important to note that although these changes were statistically significant, the mean differences were relatively modest. This may relate to the fact that this was a non-clinical sample, and participants mood and psychological function was in the normal range at baseline. Surprisingly, the effect sizes reported in the current study were in the medium to large range which is somewhat larger than those generally reported in meta-analyses and reviews examining the effects of exercise on mood states, depression and anxiety (Arent, Landers, & Etnier, 2000; Craft, Vanlterson, Helenowski, Rademaker, & Courneya, 2011; Herring et al., 2010). This may be related to the limited variability in baseline data.

An important finding of the current study is the decreased scores on the EAT which reveals that individuals in the GFC reduced their disordered attitudes, beliefs and behaviours towards eating during the 12 week GFC. To our knowledge, few studies have tracked changes in eating disordered attitudes, beliefs and behaviours with exercise interventions despite the potential for such intervention to significantly influence eating attitudes. Disordered eating attitudes, beliefs and behaviours have been implicated in weight regain following weight-loss (Elfhag & Rossner, 2005), thus developing interventions which modify eating attitudes and behaviours has the potential to further increase weight-loss maintenance.

The current study reported a trend towards a significant reduction in body image dissatisfaction associated with the GFC. Previous literature has reported associations between exercise interventions and body image (Annesi, Unruh, & Whiatker, 2007; Annesi & Whitaker, 2010; Kiernan et al., 2001), thus the finding of only a trend towards significance may reflect a lack of power due to the relatively small weight-loss observed in the current study and the previous reporting of only small to medium effect sizes for the relationship between exercise and body image

(Monshouwer et al., 2013). Furthermore the trend towards change in body image dissatisfaction providing a significant unique contribution to increased hedonic tone associated with the GFC suggests that body image changes are important in increasing positive mood states after exercise interventions. This is an important finding as few studies have investigated mediators of positive mood changes despite the proposed implications for maintenance of weight-loss (Annesi, 2007; Annesi, 2010).

Against our hypotheses, there were no effects of the GFC on self-esteem, self-efficacy or social support. Due to the non-clinical nature of the sample this may reflect a ceiling effect. That is, due to the relatively high baseline levels participants reported on these variables, the GFC did not confer additional benefits. This supports past literature in the self-esteem field which has reported that whilst a positive link between exercise and self-esteem has been established, the link is strongest in individuals reporting low self-esteem (Scully et al., 1998). Another possible explanation for the non-significant change in self-esteem and self-efficacy is that the observed weight-loss, and change in exercise behaviour was not large enough to result in significant improvements in these variables. This would support previous literature which has reported a linear relationship between actual weight-loss and change in self-esteem, with greater improvements in self-esteem among participants with greater weight loss (Kolotkin et al., 2001).

Predictors of Mood Changes Observed Following GFC

This study examined the relative effects of change in exercise, weight-loss, disordered eating attitudes and body image dissatisfaction in predicting changes in mood over the 12 week period of the GFC (or control period). Few studies have examined the relative unique and combined predictions of these variables to changes

in mood associated with exercise interventions despite calls in the literature for further investigation (Ross et al., 2009). Disordered eating attitude change made the most significant and consistent contribution to the explained variance in mood change in the regression equations. Improvements in disordered eating attitudes significantly predicted reduced depression, reduced anxiety and increased hedonic tone. Thus, evidence was found to support the hypothesised significant contribution of change in disordered eating attitudes to mood changes observed following the GFC. This reflects a novel finding and adds to the existing literature regarding the relative contributions to mood changes associated with engagement in exercise interventions. Previous researchers have reported an effect of exercise interventions on improving disordered eating attitudes, however to date the effect of this change to change in mood has not been investigated. This is significant as both improved mood and reduced disordered eating attitudes have been associated with weight-loss maintenance (e.g., Annesi, 2007; Elfhag & Rossner, 2005; Teixeira et al., 2010). Thus this finding has the potential to influence the development and refinement of exercise interventions to maximise weight-loss maintenance.

Overall, support for the hypothesised significant individual contributions of exercise and weight-loss to observed mood changes following the GFC was not found. The finding that both exercise and weight-loss did not provide significant unique contributions to changes in mood variables, with the exception of a significant contribution of weight change to change in hedonic tone, adds to the current literature which has reported mixed evidence regarding the relative importance of these factors in understanding mood changes (Langer et al., 2009; Palmeira et al., 2010; Perna et al., 1999; Ross et al., 2009). That is, of the few studies, some researchers have reported both exercise and weight-loss to contribute

significantly to improvements in mood (Langer et al., 2009; Neiman et al., 2000), other authors however have reported weight-loss, but not exercise to contribute significantly to enhanced mood (e.g. Annesi & Whitaker, 2008; Palmeira et al., 2011; Ross et al., 2009). Still others have reported significant unique contributions of exercise independent of weight loss (Annesi et al., 2007; King, Hopkins, Caudwell, Stubbs, & Blundell, 2009; Smith et al., 2007). Finally, research has also reported significant improvements across a range of psychological factors including mood following exercise intervention, however correlations between weight loss, exercise and these psychological improvements have not been significant (Imayama et al., 2011).

The finding that exercise was not a unique predictor of change in mood in the current study may be related to the fact that at both week 1 and 12 of the GFC participants were engaging in a high level of exercise. Previous research has suggested that a threshold effect exists in the relationship between exercise and mood, in that once a minimum exercise frequency and duration is met, additional improvements in mood are unlikely (Annesi & Whitaker, 2008; Annesi & Vaughn, 2011; Landers & Arent, 2001; Langer et al., 2009). For example, Annesi (2003) found reductions in depression scores did not differ significantly between those who participated in 15 minutes, versus 20-25 minutes of moderate exercise 2-3 times per week over a 10 week intervention. Thus, the current findings may reflect that at both time points GFC participants were engaging in a level of exercise beyond that reported necessary to receive mood benefits, which in turn reduced the power of this study to investigate the unique contribution of exercise. This ceiling effect of change in exercise scores was observed because, due to constraints on recruitment procedures, the GFC participants' baseline data was collected during week 1 of the

GFC and as a result participants had already began exercising. Further, whilst the control group reported less weekly exercise than the GFC group, the mean level of exercise in the control group was reported at a level beyond the minimum exercise level reported to be required to receive exercise related mood enhancing benefits (Landers & Arent, 2001). It has also been reported that exercise exerts greater mood enhancing benefits in individuals reporting worse mood and mood symptoms (Gowans et al., 2001; Smith et al., 2007), thus the current study's non-clinical participant sample, and reporting of relatively normal mood may have reduced power to identify significant effects of exercise. Future research investigating this relationship should examine exercise level prior to starting exercise intervention, and include a more sedentary control group to allow for clearer investigation into the effect of exercise on mood following exercise interventions.

The finding that weight-loss was not a unique predictor of change in depression, anxiety and energetic arousal may be related to the limited variance. That is whilst the GFC group lost significant weight during the GFC the actual weight loss was relatively small. This relatively little change in weight, in addition to the fact that at both time points the GFC group was heavier than the control group may have resulted in insufficient power to identify a unique contribution of weight-loss.

The finding that weight-loss provided a unique contribution to change in hedonic tone associated with engagement in the GFC is a novel finding. Few studies have examined the effect of exercise interventions on positive mood states with the exception of energetic arousal (Annesi, 2010). These results suggest that increased weight-loss even in the absence of changes in level of exercise, may result in an increased experience of positive mood states. This fits with previous literature which has reported decreased experience of negative mood states and symptoms of

depression and stress associated with actual weight-loss (Annesi & Whitaker, 2008; Langer et al., 2009), and also suggests a possible role of actual weight-loss in increasing positive mood states.

Eating Attitude Change Mediates Changes in Mood Following the GFC

A primary aim of this study was to investigate possible mediating variables in the relationship between GFC intervention group and mood. A mediation analysis was conducted to investigate whether changes in scores on the EAT, which reflect disordered eating attitudes, beliefs and behaviours, mediates the relationship between the GFC intervention and mood improvements. Findings of the mediation analysis reveal that EAT change is a significant mediator of the relationship between Group (the GFC intervention and controls) and hedonic tone, depression and anxiety at 12 weeks post baseline (controlling for week 1 scores as a covariate). This finding may be interpreted to mean that the GFC reduced participants disordered eating attitudes, beliefs and behaviours, and that this was a significant mechanism involved in the increased experience of positive mood states, and reduced symptoms of depression and anxiety observed following the GFC intervention. Further, it suggests that the changes in disordered eating attitudes are a mechanism by which exercise impacts on mood change in this non-clinical sample engaged in the GFC. This finding supports and extends previous research which has identified significant relationships between disordered eating attitudes, beliefs and behaviours and mood states and symptoms. Indeed previous research has revealed disordered eating attitudes, beliefs and behaviours to be associated with increased depression (Braun et al., 1994; Lane, Lane, & Matheson, 2004; Lane, 2003; Michou & Costarell, 2011; Terry, Lane, & Warren, 1997), and increased anxiety (Michou & Costarell, 2011; Michou, Costarell, & Antonopoulou, 2010).

The finding that reduced disordered eating attitudes, beliefs and behaviours associated with the GFC mediated change in hedonic tone, anxiety and depression provides one explanation for inconsistent reporting of relative importance of exercise and weight-loss variables in explaining mood changes associated with exercise interventions. That is, past research has not investigated the role of disordered eating attitudes in mood changes associated with exercise interventions, however the current findings suggest that this may be an important mechanism underlying this relationship. Furthermore, different exercise interventions have the potential to differentially effect changes in disordered eating attitudes, beliefs and behaviours. This study suggests that the GFC intervention was associated with reduced disordered eating attitudes, beliefs and behaviours, and that this change was important in the observed increases in positive mood state and reduction in symptoms of depression and anxiety. This has significant implications for the development of exercise interventions in designing interventions that include a focus on reducing disordered eating attitudes, beliefs and behaviours. Such interventions may allow for the maximum mood enhancing benefits of exercise interventions to be observed. In addition it has been reported that lowered disordered eating attitudes is associated with increased weight-loss 24 months post intervention (Tiexeira et al., 2010) suggesting an important role of change in disordered eating attitudes in weight-loss maintenance. Future studies are needed to further examine this relationship in populations with clinical levels of disordered eating attitudes, beliefs and behaviours.

Canonical correlations revealed non-significant correlation co-efficients between self-esteem, self-efficacy and social support and the mood variables of hedonic tone, energetic arousal, depression and anxiety. As such these were not

included in any mediation analysis. Whilst suggestions have been made for the mediating role of these variables (Annesi, 2012; Gowans et al., 2001; Monshouwer et al., 2013) in the current study these psychological factors were not found to significantly change during the GFC intervention, possibly due to the non clinical sample where self-esteem, self-efficacy, social support and body image were found to be in normal ranges. This ceiling effect in the data limited the opportunity for this study to accurately investigate mediation effects. As such future studies investigating clinical populations are required to test these potential mediators.

Theoretical Implications

The current findings extend the growing literature supporting the psychological models underlying mood improvements following exercise interventions (Annesi, 2010). Psychological models propose that exercise interventions lead to changes in a number of psychological variables such as self-esteem, self-efficacy, body image, disordered eating attitudes and social support, and that these changes may be associated with improved mood (Craft & Perna, 2004; Peluso & de Andrade, 2005). The current finding that changes in disordered eating attitudes, beliefs and behaviour predicted mood changes observed during the GFC adds partial support to these models. Whilst not supporting psychological models, the failure to find mediating effects of self-efficacy, self-esteem, body image and social support is likely related to ceiling and floor effects in the data and the nonclinical nature of our sample. Thus, it is premature to draw conclusions in relation to the potential mediating effects of these variables and they require testing in more clinical samples with greater variance on these measures. Whilst testing predictions of biological models was beyond the scope of this thesis, the finding of important mediating effects of attitudinal change, and the fact that changes in

disordered eating attitudes predicted greater changes in mood than exercise or weight change, lends support to integrative models which propose a combination of biological and psychological factors are involved in response to exercise (Craft & Perna, 2004; Strohle, 2009).

Limitations and Future Directions

Results of this study are not generalisable to clinical samples, as these effects were found in women without clinical or psychiatric disorders and with levels of depressed and anxious mood within the normal range. Future research needs to examine these relationships in obese populations, and with individuals with more severe anxiety and depression. Furthermore, future studies should examine these relationships following more extensive weight changes. A limitation of the current study is the small sample size and high attrition rate across the study which resulted in the mid GFC intervention (Week 6) and follow-up data (Week 16) not being included in the primary analysis. With the rising incidence of obesity, it is of particular importance for future research to examine how changes in exercise, psychological variables and mood predict the maintenance of exercise behaviours and weight loss. A further limitation of the current study was that baseline weekly exercise level was not recorded for GFC participants prior to starting the GFC, but was data collected during week 1 of the GFC. As a result a true baseline level of exercise the GFC participants were engaging in prior to starting the GFC was not obtained. Further results indicated that exercise level did not differ significantly throughout the GFC (e.g., week 1 and 12). This limited the power of this study to identify changes in mood related to changes in exercise associated with the GFC as previously described. Future research should examine exercise level prior to starting exercise intervention to allow for clearer investigation into the effect of exercise on

mood. In addition the current study reported participants' weight not BMI, thus the catagorisation of participants into standard weight categories was not possible resulting in the level of obesity in the sample to not be reported. Future studies would benefit from including a measure of BMI. It should also be noted that participants in the GFC and control group were not randomly allocated, and groups were not matched on all variables. For example the GFC and control group differed significantly in age and percent employed, thus changes observed may be attributed to other variables not controlled for in the current study. Finally, the amount of variance in mood change accounted for in regression equations was relatively modest, and it is likely that there are further variables influencing these relationships which were not examined in the current study. Future studies should continue to concurrently investigate a range of psychological and biological variables within the one design and at multiple time points throughout the exercise intervention to allow for further investigation and understanding of any mediating relationships.

Conclusions

This study found evidence that reduction in disordered eating attitudes are the most significant predictors of mood change following exercise in a non-clinical sample, and that these attitudinal changes mediate the relationship between exercise group and mood. That is, changes in disordered eating attitudes may be at least one mechanism of the impact of exercise on mood. This supports a growing literature highlighting the important of psychological variables in explaining mood improvements associated with exercise interventions. These findings have important implications in understanding the mechanisms involved in the exercise mood relationship, as well as for the development of exercise interventions to allow for maximal mood benefits to be observed.

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Appendix A

Minimal Risk Ethics Approval Letter

Social Science Ethics Officer
Private Bag 01 Hobart
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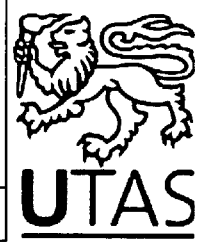
Katherine.Shaw@utas.edu.au



HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

12 September 2012

Dr Kim Felmingham
School of Psychology
Private Bag 30

Student Researcher: Kate Lennox

Sent via email

Dear Dr Felmingham

Re: MINIMAL RISK ETHICS APPLICATION APPROVAL
Ethics Ref: **H0012719 - Predictors of mood change in a combined exercise and diet weight-loss intervention**

We are pleased to advise that acting on a mandate from the Tasmania Social Sciences HREC, the Chair of the committee considered and approved the above project on 08 September 2012.

This approval constitutes ethical clearance by the Tasmania Social Sciences Human Research Ethics Committee. The decision and authority to commence the associated research may be dependent on factors beyond the remit of the ethics review process. For example, your research may need ethics clearance from other organisations or review by your research governance coordinator or Head of Department. It is your responsibility to find out if the approval of other bodies or authorities is required. It is recommended that the proposed research should not commence until you have satisfied these requirements.

Please note that this approval is for four years and is conditional upon receipt of an annual Progress Report. Ethics approval for this project will lapse if a Progress Report is not submitted.

The following conditions apply to this approval. Failure to abide by these conditions may result in suspension or discontinuation of approval.

1. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval, to ensure the project is conducted as approved by the Ethics Committee, and to notify the Committee if any investigators are added to, or cease involvement with, the project.

2. Complaints: If any complaints are received or ethical issues arise during the course of the project, investigators should advise the Executive Officer of the Ethics Committee on 03 6226 7479 or human.ethics@utas.edu.au.

3. Incidents or adverse effects: Investigators should notify the Ethics Committee immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.

4. Amendments to Project: Modifications to the project must not proceed until approval is obtained from the Ethics Committee. Please submit an Amendment Form (available on our website) to notify the Ethics Committee of the proposed modifications.

5. Annual Report: Continued approval for this project is dependent on the submission of a Progress Report by the anniversary date of your approval. You will be sent a courtesy reminder closer to this date. **Failure to submit a Progress Report will mean that ethics approval for this project will lapse.**

6. Final Report: A Final Report and a copy of any published material arising from the project, either in full or abstract, must be provided at the end of the project.

Yours sincerely

Katherine Shaw
Ethics Officer
Tasmania Social Sciences HREC

Appendix B

Social Science Ethics Officer
Private Bag 01 Hobart
Tasmania 7001 Australia
Tel: (03) 6226 2763
Fax: (03) 6226 7148
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HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

UTAS

15 November 2012

Dr Kim Felmingham
School of Psychology
Private Bag 30

Sent via email

Dear Dr Felmingham

Re: APPROVAL FOR AMENDMENT TO CURRENT PROJECT
Ethics Ref: H0012719 - **Predictors of mood change in a combined exercise and diet weight-loss intervention**

Amendment to offer a small gift voucher incentive ($20 gift voucher for a health and well-being store) for participants already enrolled in the study to complete the final two surveys.

We are pleased to advise that the Chair of the Tasmania Social Sciences Human Research Ethics Committee approved the Amendment to the above project on 15 November 2012.

Yours sincerely

Katherine Shaw
Ethics Officer
Tasmania Social Sciences HREC

Appendix C

Social Science Ethics Officer
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HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

UTAS

15 January 2013

Dr Kim Felmingham
School of Psychology
Private Bag 30

Sent via email

Dear Dr Felmingham

Re: APPROVAL FOR AMENDMENT TO CURRENT PROJECT
Ethics Ref: **H0012719 - Predictors of mood change in a combined exercise and diet weight-loss intervention**

- Amendment to extend the participant sample to include Fernwood members from Fernwood fitness clubs in New South Wales and Queensland for the March 'Get Foxy Challenge', and to recruit a control group of participants.
- Control group advertisement.
- Revised Get Foxy Challenge Survey.
- Survey for Control Participants.
- Information Sheet for Control Participants.

We are pleased to advise that the Deputy Chair of the Tasmania Social Sciences Human Research Ethics Committee approved the Amendment to the above project on 14 January 2013.

Yours sincerely

Katherine Shaw
Ethics Officer
Tasmania Social Sciences HREC

Appendix D

Social Science Ethics Officer
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HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

UTAS

27 February 2013

Dr Kim Felmingham
School of Psychology
Private Bag 30

Sent via email

Dear Dr Felmingham

Re: APPROVAL FOR AMENDMENT TO CURRENT PROJECT
Ethics Ref: **H0012719 - Predictors of mood change in a combined exercise and diet weight-loss intervention**

- Amendment to include a prize draw for participants to enter to win an Apple iPad.
- Revised advertisements for both control and Get Foxy Challenge participants.

We are pleased to advise that the Chair of the Tasmania Social Sciences Human Research Ethics Committee approved the Amendment to the above project on 26 February 2013.

Yours sincerely

Katherine Shaw
Ethics Officer
Tasmania Social Sciences HREC

Appendix E

UTAS

PARTICIPANT INFORMATION SHEET
SOCIAL SCIENCE/ HUMANITITES
RESEARCH

Predictors of mood change in a combined exercise and diet weight-loss intervention

Invitation

You are invited to participate in a research study investigating the effect of the 'Get Foxy Challenge' on womens' mood and well-being. This study is being conducted by Kate Lennox (masters student), supervised by Dr Kim Felmingham (masters supervisor) and Dr Andrea Carr (masters supervisor) in partial fulfilment of the requirements of an Masters degree in the School of Psychology at the University of Tasmania.

'What is the purpose of this study?'

The purpose of this study is to investigate the effect of the 12 week 'Get Foxy Challenge' on women's mood and well-being. More specifically this study aims to investigate whether exercise participation, weight loss, social support and thoughts about oneself are related to changes in feelings of negative and positive mood during and following the 12 week 'Get Foxy Challenge'.

2. 'Why have I been invited to participate in this study?'

You have been invited to participate in this study because you are enrolled in Fernwood's 'Get Foxy Challenge'.

4. 'What does this study involve?'

Participation in the current study involves the completion of a short survey at four time points throughout and following the 'Get Foxy Challenge'. The survey can be completed online or as a pen and paper survey and takes approximately twenty minutes to complete. The survey consists of a number of short questionnaires relating to demographic variables, general medical health and mental health and wellbeing. The questionnaires ask about a number of different aspects of mood and wellbeing, including recent feelings of positive and negative mood, stress, body image, social support, self-efficacy, self-esteem, and cognitive/thinking style. The survey also has a section to record your progress during the 'Get Foxy Challenge' in terms of exercise participation and weight as recorded in your 'Get Foxy Challenge' diary.

It is important that you understand that your involvement is this study is voluntary. While we would be pleased to have you participate, we respect your right to decline. There will be no consequences to you if you decide not to participate. If you decide to discontinue participation at any time, you may do so without providing an explanation.

All information collected will be treated in a confidential manner, and your name will not be used in any publication arising out of the research. All of the research will be kept securely on the Universty of Tasmania's (UTAS) secure server, or in a locked cabinet or on password protected computers in the Cognitive Neuroscience Laboratory at UTAS. All information collected will be securely destroyed five years after publication of the data.

5. Are there any possible benefits from participation in this study?
Through participation in this study you may become more aware of the effect of the 'Get Foxy Challenge' on your mood and wellbeing. Further, if we are able to take the findings of this study and link them with recent research conducted in the area, the results may lead to the identification of important predictors of success in improving exercise and diet.

6. Are there any possible risks from participation in this study?
There are no specific risks anticipated with participation in this study.

7. What if I have questions about this research?
If you would like to discuss any aspect of this study please feel free to contact either Kate Lennox at klennox@utas.edu.au, Kim Felmingham at K.Felmingham@utas.edu.au or ph. (03) 62261965 or Andrea Carr at A.R.Carr@utas.edu.au or ph. (03) 62262244 . We would be happy to discuss any aspect of the research with you. Once we have analysed the information we will be putting a summary of our findings on the web for you to view. You are welcome to contact us at any time to discuss any issues relating to the research study.

This study has been approved by the Tasmanian Social Science Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study should contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. You will need to quote [*HREC project number*].

Thank you for taking the time to consider this study.
If you wish to take part in it, please sign the attached consent form.
This information sheet is for you to keep.

Appendix F

UTAS

CONSENT FORM

Predictors of mood change in a combined exercise and diet weight-loss intervention

1. I have read and understood the 'Information Sheet' for this project.
2. The nature and possible effects of the study have been explained to me.
3. I understand that the study is investigating the effect of the 12 week 'Get Foxy Challenge' on participants' mood and wellbeing. I understand participation involves completing a number of questionnaires detailing general medical health and demographic information, recent feelings of positive and negative mood, stress, body image, social support, self-efficacy, self-esteem and cognitive/thinking style, as well as perceived quality of life. I understand that the survey also asks for my exercise participation and weight as recorded in my 'Get Foxy Challenge' diary. I understand that participation involves completing the survey four times, once prior to starting the 'Get Foxy Challenge', during weeks 8 and 12, and finally 4 weeks after completing the 'Get Foxy Challenge'. I also understand that the survey is expected to take less than 20 minutes to complete.
4. I understand that participation involves minimal risk.
5. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years, and will then be destroyed.
6. Any questions that I have asked have been answered to my satisfaction.
7. I agree that research data gathered from me for the study may be published provided that I cannot be identified as a participant.
8. I understand that the researchers will maintain my identity confidential and that any information I supply to the researcher will be used only for the purposes of the research.
9. I agree to participate in this investigation and understand that I may withdraw at any time without any effect, and if I so wish, may request that any data I have supplied to date be withdrawn from the research.

Name of Participant:

Signature: Date:

Statement by Investigator

☐ I have explained the project & the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have the opportunity to contact me prior to consenting to participate in this project.

Name of Investigator

Signature of Investigator

Name of investigator _____

Signature of investigator _____ _____

Date

Appendix G

General Demographic and Medical History Questionnaire

Age: .....

Are you currently married or in a de-facto relationship? *Yes/No*

Are you currently employed? Yes / No

What is the highest level of educational you have completed?
.....

Are you currently suffering from anxiety or depression? *Yes / No*

In the past, have you ever been diagnosed with any anxiety or depressive disorder? *Yes / No*

If *Yes* please describe .....

Do you have a heart condition or any other serious physical condition? *Yes / No*

In the past four weeks have you experienced any adverse or stressful events? *Yes / No*

If *Yes* please describe .....

Based on the past 4 weeks, how often on average would you socialise with friends in ONE WEEK? (please circle)

Never Less than once A few days Most days Everyday

Appendix H

Weight Log

Please enter your weight (kg)

Week	Weight (kg)
1	
6	
12	
16	

Appendix I

International Physical Activity Questionnaire (Ainsworth et al., 2000)

Thinking about the past 4 WEEKS, how many minutes in an average WEEK would you spend engaging in each of the following types of exercise?

Aerobics based gym class (e.g., attack, combat) _____
Spin Class_____
Yoga/Core Class _____
Pump Class/ Weights _____
Jogging (<10 km/hr) _____
Running (>10 km/hr) _____
Cycling _____
Tem Sports (e.g., netball) _____
Personal Training Sessions _____
'Get Foxy Challenge' Group Personal Training _____
Power Walking _____
Other types of exercise (please describe) _____

Appendix J

Depression, Anxiety and Stress Scale (DASS- 21)

Please read each statement and record a number 0, 1, 2 or 3 which indicates how much the statement applied to you *over the past week.* There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:
0 - Did not apply to me at all
1 - Applied to me to some degree, or some of the time
2 - Applied to me to a considerable degree, or a good part of time
3 - Applied to me very much, or most of the time

Statement	Rating
1. I found it hard to wind down	
2. I was aware of dryness of my mouth	
3. I couldn't seem to experience any positive feeling at all	
4. I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	
5. I found it difficult to work up the initiative to do things	
6. I tended to over-react to situations	
7. I experienced trembling (eg, in the hands)	
8. I felt that I was using a lot of nervous energy	
9. I was worried about situations in which I might panic and make a fool of myself	
10. I felt that I had nothing to look forward to	
11. I found myself getting agitated	
12. I found it difficult to relax	
13. I felt down-hearted and blue	
14. I was intolerant of anything that kept me from getting on with what I was doing	
15. I felt I was close to panic	
16. I was unable to become enthusiastic about anything	
17. I felt I wasn't worth much as a person	
18. I felt that I was rather touchy	
19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	
20. I felt scared without any good reason	
21. I felt that life was meaningless	

Appendix K
UNISW Mood Adjective Checklist (UMACL; Matthews, & Jones, 1990)

Thinking about the past WEEK, please indicate how often you have experienced the following feelings.

	Extremely	Quite a but	Moderately	A little	Slightly or not at all
Cheerful	1	2	3	4	5
Contented					
Satisfied					
Happy					
Dissatisfied					
Depressed					
Sad					
Sorry					
Anxious					
Jittery					
Tense					
Nervous					
Calm					
Restful					
Relaxed					
Composed					
Active					
Energised					
Alert					
Vigorous					
Unenterprising					
Sluggish					
Tired					
Passive					
Impatient					
Annoyed					
Angry					
Irritated					
Grouchy					

Appendix L

Berlin Social Support Questionnaire – Revised (BSSS-R)

We would like to know how you have been feeling about your social support network and your engagement in, and need for, social support over the past week. Please read each question and circle the appropriate number to the right. Please answer all the questions.

OVER THE PAST WEEK:

	Not true at all	Barely true	Moderately true	Exactly true
1. There are people who truly like me	1	2	3	4
2. Whenever I am not feeling well, other people show me that they are fond of me	1	2	3	4
3. Whenever I am sad, there are people who cheer me up	1	2	3	4
4. There is always someone there for me when I need comforting	1	2	3	4
5. I know some people whom I can always rely	1	2	3	4
6. When I am worried, there is someone who helps me	1	2	3	4
7. There are people who offer me help when I need it	1	2	3	4
8. When everything becomes to much for me to handle, others are there to help me	1	2	3	4
9. When I am down, I need someone who boosts my spirits	1	2	3	4
10. It is important for me to have someone who listens to me	1	2	3	4
11. Before making any important decisions, I absolutely need a second opinion.	1	2	3	4
12. I get along best without any outside help	1	2	3	4
13. In critical situations, I prefer to ask others for their advice	1	2	3	4
14. Whenever I am down, I look for someone to cheer me up again	1	2	3	4
15. When I am worried, I reach out to someone to talk to	1	2	3	4
16. If I do not know how to handle a situation, I ask others what they would do	1	2	3	4

Appendix M

Eating Attitudes Test – 26

We would know like to ask some questions about your attitudes, beliefs and behaviours in regards to food, body shape and weight. Please read each statement and thinking about the past WEEK circle the appropriate number to the right.

	Never	Rarely	Sometimes	Often	Very Often	Always
I am terrified about being overweight	1	2	3	4	5	6
I avoid eating when I am hungry	1	2	3	4	5	6
I find myself preoccupied with food	1	2	3	4	5	6
I have gone on eating binges where I feel that I may not be able to stop	1	2	3	4	5	6
I cut my food into small pieces	1	2	3	4	5	6
I am aware of the caloric content of foods that I eat	1	2	3	4	5	6
I particularly avoid food with a high carbohydrate content	1	2	3	4	5	6
I feel that others would prefer I ate more	1	2	3	4	5	6
I vomit after I have eaten	1	2	3	4	5	6
I feel extremely guilty after eating	1	2	3	4	5	6
I am occupied with a desire to be thinner	1	2	3	4	5	6
I think about burning up calories when I exercise	1	2	3	4	5	6
Other people think I am to thin	1	2	3	4	5	6
I am preoccupied with the thought of having fat on my body	1	2	3	4	5	6
I take longer than others to eat my meals	1	2	3	4	5	6
I avoid food with sugar in them	1	2	3	4	5	6
I eat diet foods	1	2	3	4	5	6
I feel that food controls my life	1	2	3	4	5	6
I display self-control	1	2	3	4	5	6

around food						
I feel that others pressure me to eat	1	2	3	4	5	6
I give too much time and thought to food	1	2	3	4	5	6
I feel uncomfortable after eating sweets	1	2	3	4	5	6
I engage in dieting behaviour	1	2	3	4	5	6
I like my stomach to be empty	1	2	3	4	5	6
I have the impulse to vomit after meals	1	2	3	4	5	6
I enjoy trying new rich foods	1	2	3	4	5	6

Appendix N

Body Shape Questionnaire – 8c

We would like to know how you have been feeling about your appearance over the **PAST WEEK**. Please read each question and circle the appropriate number to the right.

	Never	Rarely	Sometimes	Often	Very Often	Always
Have you been afraid that you might become fat (or fatter)?	1	2	3	4	5	6
Has feeling full (e.g. after eating a large meal) made you feel fat?	1	2	3	4	5	6
Has thinking about your shape interfered with your ability to concentrate (e.g. while watching television, reading, listening to conversations)?	1	2	3	4	5	6
Have you imagined cutting off fleshy areas of your body?	1	2	3	4	5	6
Have you felt excessively large and rounded?	1	2	3	4	5	6
Have you thought that you are in the shape you are because you lack self-control?	1	2	3	4	5	6
Has seeing your reflection (e.g. in a mirror or shop window) made you feel bad about your shape?	1	2	3	4	5	6
Have you been particularly self-conscious about your shape when in the company of other people?	1	2	3	4	5	6

Appendix O

General Self-Efficacy Scale (GSE)

We would like to know how you have been feeling about your perceived capabilities in a number of situations over the last week. Please read each question and circle the appropriate number to the right. Please answer all the questions.

OVER THE PAST WEEK:

	Not true at all	Barely true	Moderately true	Exactly true
1. I can always manage to solve difficult problems if I try hard enough.	1	2	3	4
2. If someone opposes me, I can find the means and ways to get what I want.	1	2	3	4
3. It is easy for me to stick to my aims and accomplish my goals	1	2	3	4
4. I am confident that I could deal efficiently with unexpected events.	1	2	3	4
5. Thanks to my resourcefulness, I know how to handle unforeseen situations	1	2	3	4
6. I can solve most problems if I invest the necessary effort.	1	2	3	4
7. I can remain calm when facing difficulties because I can rely on my coping abilities.	1	2	3	4
8. When I am confronted with a problem, I can usually find several solutions	1	2	3	4
9. If I am in trouble, I can usually think of a solution.	1	2	3	4
10. I can usually handle whatever comes my way.	1	2	3	4

Appendix P

Rosenberg Self-Esteem Scale (Rosenberg, 1965)

Thinking about the past week please indicate how strongly you agree with the following statements.

	Strongly Agree	Agree	Disagree	Strongly Disagree
On the whole, I am satisfied with myself.	1	2	3	4
There have been times I think I am no good at all	1	2	3	4
I have felt that I have a number of good qualities.	1	2	3	4
I am able to do things as well as most other people	1	2	3	4
I have felt I do not have much to be proud of	1	2	3	4
I have certainly feel useless at times	1	2	3	4
I have felt I do not have much to be proud of	1	2	3	4
I have certainly felt useless at times.	1	2	3	4
I have felt that I'm a person of	1	2	3	4
I wish I could have more respect for myself	1	2	3	4
All in all, I am inclined to think that I am a failure	1	2	3	4
I have taken a positive attitude toward myself	1	2	3	4

Appendix Q
Collinearity Table of Correlation Co-efficients

		group	Hedonic_ Tone	Energetic_Ar ousal	Change_Dep T13	Anx_changeT 3_T1	Ex_changeT 3_T1	SS_changeT 3_T1	weight_changeT 3_T1	SE_changeT 3_T1	GSE_changeT 3_T1	BSQ_changeT 3_T1	EAT_changeT 3_T1
group	Pearson and product Correlation	1	-.105	.018	-.369**	-.369**	.005	.000	-.446**	.160	.121	-.244	-.291*
	Sig. (2-tailed)		.434	.894	.005	.005	.971	.999	.000	.234	.364	.064	.028
	Cross-products	12.017	-15.086	2.776	-22.281	-22.281	42.776	.034	-43.164	16.614	12.741	-45.500	-49.421
	Covariance	.211	-.265	.049	-.398	-.398	.750	.001	-.757	.297	.224	-.798	-.883
	N	58	58	58	57	57	58	58	58	57	58	58	57
Hedonic_Tone	Pearson Correlation	-.105	1	.666**	.133	.133	.147	-.238	.068	-.208	-.142	.102	.296*
	Sig. (2-tailed)	.434		.000	.325	.325	.272	.072	.613	.121	.287	.448	.025

	Sum of Squares and Cross-products	-15.086	1724.431	1243.121	97.544	97.544	15242.121	-413.172	78.619	-256.509	-178.707	226.500	613.789
	Covariance	-.265	30.253	21.809	1.742	1.742	267.406	-7.249	1.379	-4.581	-3.135	3.974	10.961
	N	58	58	58	57	57	58	58	58	57	58	58	57
	Pearson Correlation	.018	.666**	1	.231	.231	-.078	-.169	-.099	-.178	-.037	.139	.257
	Sig. (2-tailed)	.894	.000		.084	.084	.561	.205	.459	.186	.786	.297	.054
Energetic_Arousal	SS and Cross-products	2.776	1243.121	2018.914	184.825	184.825	-8758.086	-317.448	-124.471	-239.123	-49.638	336.500	570.895
	Covariance	.049	21.809	35.420	3.300	3.300	-153.651	-5.569	-2.184	-4.270	-.871	5.904	10.195
	N	58	58	58	57	57	58	58	58	57	58	58	57

	Pearson Correlation	-.369**	.133	.231	1	1.000**	-.086	-.248	-.016	-.144	.055	.279*	.382**
	Sig. (2-tailed)	.005	.325	.084		.000	.522	.063	.908	.291	.687	.036	.004
Change_Dep_T13	SS and Cross-products	-22.281	97.544	184.825	316.982	316.982	-3823.632	-184.596	-7.619	-75.714	29.404	263.351	340.482
	Covariance	-.398	1.742	3.300	5.660	5.660	-68.279	-3.296	-.136	-1.377	.525	4.703	6.191
	N	57	57	57	57	57	57	57	57	56	57	57	56
	Pearson Correlation	-.369**	.133	.231	1.000**	1	-.086	-.248	-.016	-.144	.055	.279*	.382**
Anx_changeT3_T1	Sig. (2-tailed)	.005	.325	.084	.000		.522	.063	.908	.291	.687	.036	.004

	SS and Cross-products	-22.281	97.544	184.825	316.982	316.982	-3823.632	-184.596	-7.619	-75.714	29.404	263.351	340.482
	Covariance	-.398	1.742	3.300	5.660	5.660	-68.279	-3.296	-.136	-1.377	.525	4.703	6.191
	N	57	57	57	57	57	57	57	57	56	57	57	56
	Pearson Correlation	.005	.147	-.078	-.086	-.086	1	-.043	.091	-.273*	.107	.012	.041
	Sig. (2-tailed)	.971	.272	.561	.522	.522		.751	.497	.040	.426	.930	.762
Ex_changeT3_T1	SS and Cross-products	42.776	15242.121	-8758.086	-3823.632	-3823.632	6266930.914	-4467.448	6369.629	-19835.947	8073.362	1596.500	5146.211
	Covariance	.750	267.406	-153.651	-68.279	-68.279	109946.156	-78.376	111.748	-354.213	141.638	28.009	91.897
	N	58	58	58	57	57	58	58	58	57	58	58	57

	Pearson Correlation	.000	-.238	-.169	-.248	-.248	-.043	1	.162	.311*	-.040	-.236	-.275*
	Sig. (2-tailed)	.999	.072	.205	.063	.063	.751		.224	.019	.766	.074	.038
SS_changeT3_T1	SS and Cross-products	.034	-413.172	-317.448	-184.596	-184.596	-4467.448	1750.069	189.372	382.105	-50.517	-531.000	-576.368
	Covariance	.001	-7.249	-5.569	-3.296	-3.296	-78.376	30.703	3.322	6.823	-.886	-9.316	-10.292
	N	58	58	58	57	57	58	58	58	57	58	58	57
	Pearson Correlation	-.446**	.068	-.099	-.016	-.016	.091	.162	1	-.138	-.224	.302*	.018
weight_changeT3_T1	Sig. (2-tailed)	.000	.613	.459	.908	.908	.497	.224		.308	.090	.021	.893

	SS and Cross-products	-43.164	78.619	-124.471	-7.619	-7.619	6369.629	189.372	780.836	-114.174	-189.843	452.950	25.505
	Covariance	-.757	1.379	-2.184	-.136	-.136	111.748	3.322	13.699	-2.039	-3.331	7.946	.455
	N	58	58	58	57	57	58	58	58	57	58	58	57
	Pearson Correlation	.160	-.208	-.178	-.144	-.144	-.273*	.311*	-.138	1	.260	-.223	-.348**
	Sig. (2-tailed)	.234	.121	.186	.291	.291	.040	.019	.308		.051	.096	.009
SE_changeT3_T1	SS and Cross-products	16.614	-256.509	-239.123	-75.714	-75.714	-19835.947	382.105	-114.174	900.877	224.491	-350.386	-427.179
	Covariance	.297	-4.581	-4.270	-1.377	-1.377	-354.213	6.823	-2.039	16.087	4.009	-6.257	-7.767
	N	57	57	57	56	56	57	57	57	57	57	57	56

	Pearson Correlation	.121	-.142	-.037	.055	.055	.107	-.040	-.224	.260	1	-.276*	-.083
	Sig. (2-tailed)	.364	.287	.786	.687	.687	.426	.766	.090	.051		.036	.538
GSE_changeT3_T1	SS and Cross-products	12.741	-178.707	-49.638	29.404	29.404	8073.362	-50.517	-189.843	224.491	915.879	-448.500	-125.947
	Covariance	.224	-3.135	-.871	.525	.525	141.638	-.886	-3.331	4.009	16.068	-7.868	-2.249
	N	58	58	58	57	57	58	58	58	57	58	58	57
	Pearson Correlation	-.244	.102	.139	.279*	.279*	.012	-.236	.302*	-.223	-.276*	1	.523**
BSQ_changeT3_T1	Sig. (2-tailed)	.064	.448	.297	.036	.036	.930	.074	.021	.096	.036		.000

	SS and Cross-products	-45.500	226.500	336.500	263.351	263.351	1596.500	-531.000	452.950	-350.386	-448.500	2884.500	1401.368
	Covariance	-.798	3.974	5.904	4.703	4.703	28.009	-9.316	7.946	-6.257	-7.868	50.605	25.024
	N	58	58	58	57	57	58	58	58	57	58	58	57
	Pearson Correlation	-.291*	.296*	.257	.382**	.382**	.041	-.275*	.018	-.348**	-.083	.523**	1
	Sig. (2-tailed)	.028	.025	.054	.004	.004	.762	.038	.893	.009	.538	.000	
EAT_changeT3_T1	SSand Cross-products	-49.421	613.789	570.895	340.482	340.482	5146.211	-576.368	25.505	-427.179	-125.947	1401.368	2506.211
	Covariance	-.883	10.961	10.195	6.191	6.191	91.897	-10.292	.455	-7.767	-2.249	25.024	44.754
	N	57	57	57	56	56	57	57	57	56	57	57	57

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

ss= sum of squares